TK
5700
M372
v.5
no.11
c.1
Engin
Serial

ENGI STORAGE

Notice to Reader — When you finish reading this magazine, place a 1-cent stamp on this notice, mail the magazine, and it will be placed in the hands of our soldiers or sailors destined to proceed overseas.

No wrapping. No Address

The WIRELESS AGE

Practical Training Courses in
Aviation — Wartime Wireless
Navigation — Military Signaling

And a Special Feature:

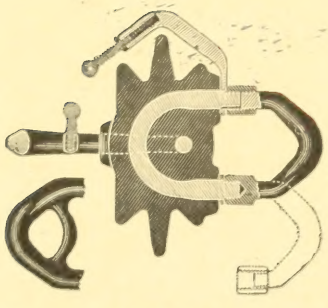
The Pan-American Wireless Chain

BUY WAR SAVINGS STAMPS

FOR ALL THERE IS IN IT—

THIS IS OUR WAR—

WE MUST WIN IT.



165 A.

ELECTROSE MARK

ARCOVER TRADE MARK

INSULATION
"MADE IN AMERICA"
LOUIS STEINBERGER'S PATENTS

LIGHTNING-PROOF INSULATORS

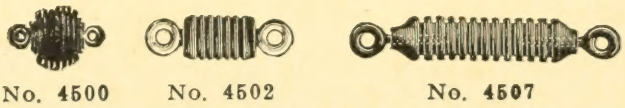
1,000 TO 1,000,000 VOLTS

ELECTROSE INSULATORS ARE STANDARD WITH
UNITED STATES NAVY AND ARMY

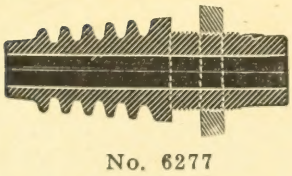
AND WIRELESS TELEGRAPH AND TELEPHONE COMPANIES

No. 7370

No. 6815



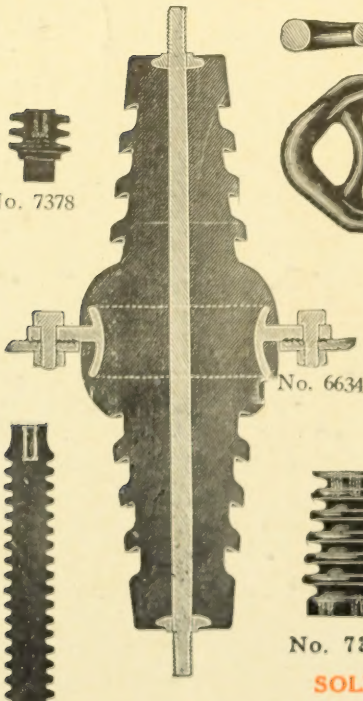
No. 4500 No. 4502 No. 4507



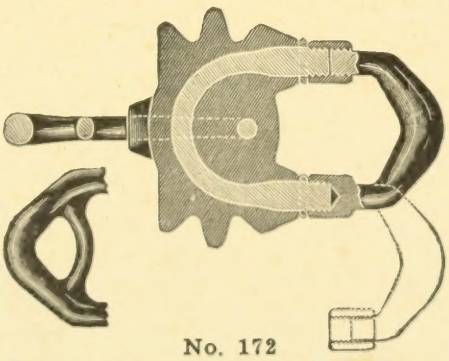
No. 6277

No. 4518

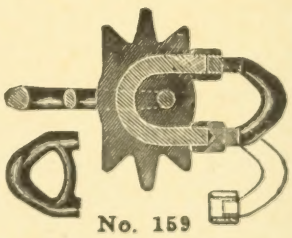
No. 7378



No. 6634

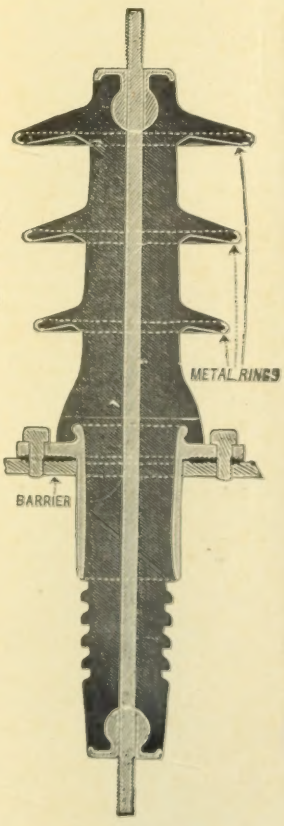


No. 172



No. 159

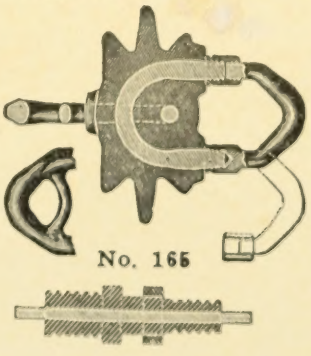
No. 7379



No. 7163

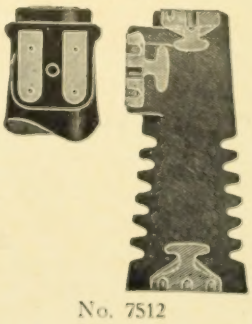
No. 7487

No. 7375



No. 165

No. 6833



No. 7512

SOLE MANUFACTURERS

ELECTROSE MFG. CO.

66-82 Washington St.
66-76 Front St.

27-37 York St.
1-23 Flint St.

Brooklyn, N. Y., America

Quality That Speaks

Far more than we can say about Weston pre-eminence is revealed fully, unmistakably, emphatically, in every detail of

Weston

Indicating Instruments

Their superiority is so marked, so easily demonstrated by test, that only one decision will be consistent after you have made comparisons.

Weston Electrical Instrument Co.
27 Weston Ave., Newark, N. J.
23 Branches in the Larger Cities

Weston Round Pattern Switchboard Instruments of 7-inch diameter are the standard for use on Wireless Telegraph Panels. As they are of the highest grade and designed for commercial installation, they are not adapted to experiments in wireless work. Write for more specific information.

Study Wireless at the Marconi Institute

AMERICA is famous for its educational institutions.

The young men of this country have learned to regard certain schools as leaders in particular lines of study. Harvard is noted for its law school, Cornell for its engineering course, Johns Hopkins for medicine, Philadelphia for dentistry and the Marconi Institute for Wireless.

These schools have all justly earned their fame from long years of experience, especially picked training staffs and elaborately equipped libraries and laboratories.

The Marconi Institute offers the young man of America a wonderful opportunity to study radio in a modern school, ideally located in the heart of New York City where he can mingle with men from all quarters of the globe.

The Institute gives direct instruction on Submarine, Airplane, Cargo and Passenger Ship apparatus. Vacuum Tubes are especially featured.

The radio laboratory of the Institute is more completely equipped than other training organizations of its kind in the United States.

Students are not only taught the theories of the art but they are given the opportunity to manipulate and adjust the most modern types of apparatus in use in the year 1918. Moreover they receive the benefit of the years of practical experience of the several instructors—men who have been identified with the commercial, scientific research and administrative branches of radio communication since its inception.

It goes without saying that promotion in war time as in civil life is the outcome of knowledge.

The man whose patriotism impels him to serve the government, should prepare himself in one of the arts recognized as of supreme value to the successful culmination of the war. Among these the profession of radio stands out foremost.

The prospective applicant should bear in mind that the Marconi Institute has more than 4,000 graduates to its credit. The majority are now serving in either the Army or the Navy. Thousands of men are still required by the government.

Students may attend day or evening classes throughout the year. The New York school alone has facilities for teaching 600 students a day.

The Institute is open daily for inspection and you are cordially invited to visit the school any day from 10 A. M. to 10 P. M. except Saturday on which day the school closes at noon.

Prospective students are always welcome for personal interviews.

A very interesting and instructive, fully illustrated 96 page manual has been prepared showing the possibilities and opportunities in the radio field and the facilities for training young men at the Marconi Institute. A copy will be gladly forwarded to you upon request.

Address

Director of Instruction, Marconi Institute

25 Elm Street, New York City

BRANCH SCHOOLS:

Room 361-70, Lenox Bldg., Euclid Ave. and East 9th St., Cleveland, Ohio
New Call Building, New Montgomery Street, San Francisco, Cal.

Addresses of other branch schools to be announced later

LEARN TELEGRAPHY QUICKER—EASIER

WITH THE NEW

MORSE OR WIRELESS CODE

ADJUSTABLE BUZZER PRACTICE SET.

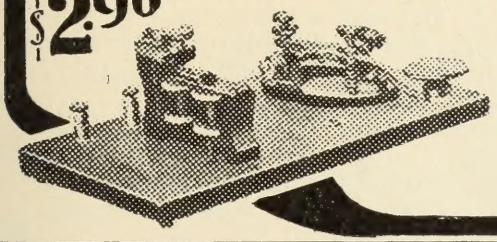
NO TOOLS—A TOUCH OF YOUR FINGER ADJUSTS IT.

QUICKLY GIVES YOU SPEED

This practice set with its adjustable BUZZER enables you to learn telegraphy, Morse or Wireless Code, in shorter time than ever before thought possible. A touch of your finger to a thumb screw gives any pitch desired to the BUZZER. Especially designed to give very clear sound of exceptionally high pitch even on ONE DRY CELL.

The adjustment of the Buzzer to any pitch is made without the aid of any tools—simply by the thumb screw. The greatest improvement in practice sets ever made—superior to any on the market. Beautifully made; mounted on substantial base.

AS SHOWN WITHOUT BATTERY $2.90



Price $3.50 WITH BATTERY AND WIRE

Complete Ready for Use *Immediate Delivery*

THE TEWNO CO.

Dept. B 41 Park Row, New York, N. Y.

The "Exide" Battery

means "Safety First" for Wireless and Emergency Lighting. It means an assurance of real dependable power—power that is instantly ready when emergency demands it.

The "Exide" is described and illustrated in Bulletin No. 168. Send for your copy.

THE ELECTRIC STORAGE BATTERY CO.

The oldest and largest manufacturer of Storage Batteries in the country

New York Boston PHILADELPHIA, PA. Chicago Denver
St. Louis Cleveland Atlanta 1888-1918 Rochester Detroit Toronto
Minneapolis Washington Pittsburgh San Francisco Kansas City

Service and Quality

Drawing Materials
Surveying Instruments
Sensitized Papers

Quality products delivered when you want them.
Try our Gold Seal blue print paper —100% pure—100% satisfaction.
Working samples on request.

New York Blue Print Paper Co.

102 Reade St., New York City

Write for Catalog W

SILVER

FOR

Spark Gaps or Contacts

WE CAN FURNISH immediately: Pure silver for sparking purposes on quenched spark gaps. Sterling silver for contacts on sending or relay keys. Pure granulated silver for coatings on Leyden Jars.

Ask for our prices

HANDY AND HARMAN

NEW YORK PLANT

29 GOLD STREET NEW YORK

The Wireless Age

Edited by J. ANDREW WHITE

Vol. 5 — Contents for August, 1918 — No. 11

Page

COVER
Student Aviators of the Signal Corps Learning Wireless at Columbia University.

WORLD WIDE WIRELESS
Unmanned Airplane to Be Under Wireless Control 883
Hun Uses His Wireless to Spread Lies About Americans..... 883
An Inland Tribute to Patriotic Operators 884
Suspected Spy Stations Raided in Chicago 884
Hun Attempt to Destroy Liberian Wireless Plant 885
Substantial Wireless Progress in Australia 885

PROFESSIONAL OPERATORS
When the Florizel Struck Horn Reef. 886

RADIO SCIENCE
The Pan-American Wireless Chain.. 891
The Use of Telegraph and Telephone Lines 897
Novelty in Spark Design..... 897
A Spark Gap Designed to Reduce Resistance 899
Protection for Wireless Aerial in the Submarine Zone 904
High Power Stations—By C. H. Taylor 931
The Dynatron—By Albert W. Hull, Ph.D. 941

MILITARY PREPAREDNESS
Wartime Wireless Instruction—By Elmer E. Bucher (Article XVI).. 905
Signal Officers' Training Course—By Major J. Andrew White (Fifteenth Article) 913
Signal Corps News..... 918
How to Become an Aviator—By Major J. Andrew White and Henry Woodhouse (Thirteenth Article).. 919
Aviation News 926
Military Airmen — Major William Thaw 928
Visual Signaling for the Army—By Lieut.-Col. B. O. Lenoir, Signal Corps, U. S. A..... 929

MARINE INSTRUCTION
Finding Your Way Across the Sea—By Capt. Fritz E. Uttmark..... 937
Navigation News 939

EXPERIMENTERS' WORLD
First Prize—A Receiving Set for a Wide Range of Wave Lengths..... 953
Second Prize—Convenient Chart in Making Wireless Calculations..... 958
Third Prize—An Inductively Coupled Receiving Transformer 959
Changing From the Vacuum Tube to the Crystal Detector 960
A Multi-layered Tuning Coil..... 961
A Novel Method for Changing Degrees Fahrenheit to Degrees Centigrade or Vice Versa..... 962
A Novel Electric Inspection Lamp and Magnet 963
Farm Wireless News 964
A Telephone Without Diaphragms for Code Practice 966
Queries Answered 967

Index of Equipment

Page

Automatic Transmitters
Omnigraph Mfg. Co. VI

Blue Print Paper
New York Blue Print Paper Co. III

Books
Wireless Press, Inc., 955, 956, 961, 962, 963, 964, 965, 966, 967, 968

Bronze and Aluminum Castings
Fischer-Sweeny Bronze Co...954

Electrical Equipment
Charles F. Campbell..... VI
Dubilier Condenser Co., Inc... V
Electrose Mfg. Co. Inside Front Cover
Manhattan Electrical Supply Co., Inc. 959
Miller-Reese-Hutchison, Inc. Inside Back Cover
The Continental Fibre Co... VII
The Electric Storage Battery Co. III
The Tewno Co..... III
The William B. Duck Co..... 963
Weston Electrical Instrument Co. I
Wireless Press, Inc..... 958

Instruction
Dodge's Telegraph, Ry. & Wireless Institute 966
Eagle Aviation School..... 964
Eastern Radio Institute..... 963
Marconi Institute .....II, 962
Marconi-Victor Records 969
National Aero Institute..... 964
Uttmark's Nautical Academy.. 957
Y. M. C. A. Radio School... 963

Motors
Crocker-Wheeler Co...Back Cover

Patents
Watson E. Coleman..... 964

Printing
McConnell Printing Co..... 959

Silver
Handy and Harman..... III

Tools and Supplies
T. P. Walls Tool & Supply Co., Inc. VI

Wireless Telegraph Service
Pan-American Wireless Telegraph and Telephone Co... 970

RENEWALS—When subscription expires, find a renewal blank enclosed. Return with remittance promptly.
CHANGE OF ADDRESS—Notify us of any change in your address, giving both the old and new location.

Published Monthly by Wireless Press, Inc., 25 Elm Street, New York

Edward J. Nally, Pres. Charles J. Ross, Vice-Pres. David Sarnoff, Secy. John Bottomley, Treas.

Yearly Subscription in U. S., $2.00; Outside U. S., $2.48; Single Copies, 20 cents

Entered as second class matter at the Post Office, New York.

DUBILIER
MICA CONDENSERS

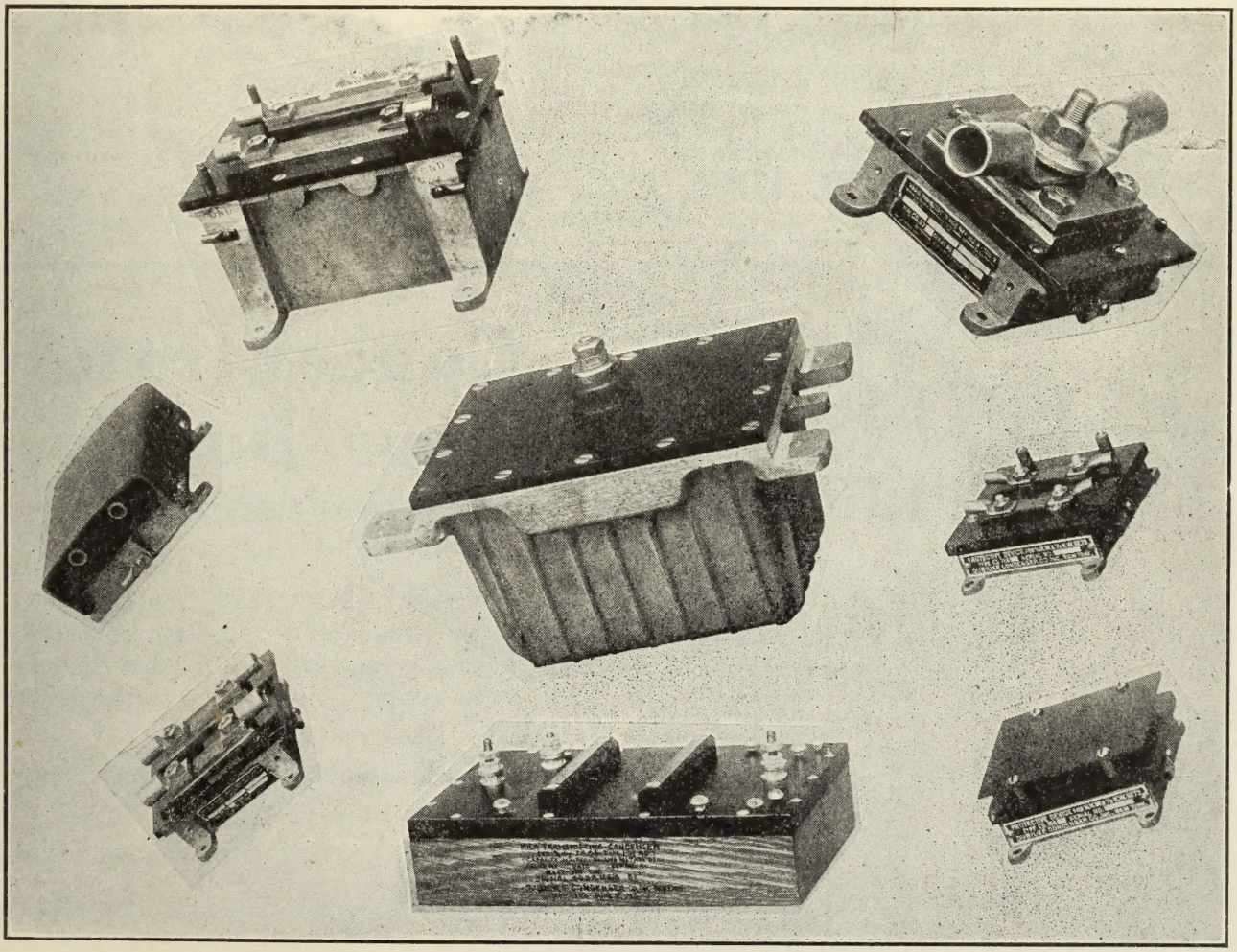
For any voltage and capacity. .004 mf Units to fit all Standard Racks.

Used by the Marconi Company

MICA SELF HEALING

Protective Devices for all size equipments from ¼ to 500 K. W.
Protect your Motors and Generators from burning out.

Up to further notice only U. S. Government Equipments will be supplied

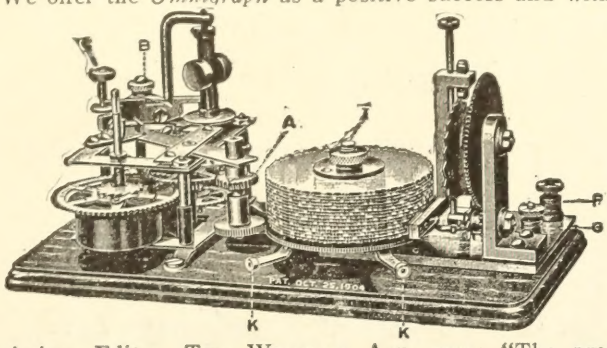


DUBILIER CONDENSER CO., Inc.

217 CENTRE STREET NEW YORK

LEARN THE CODE WITH THE OMNIGRAPH

The Omnigraph Automatic Transmitter will teach you the Continental and the Morse Codes, *at home, in half the usual time* and at the least possible expense.
The *Omnigraph,* connected with Buzzer or Sounder, will send you unlimited Wireless or Morse Code messages, *by the hour* and at any *speed* you desire. Invaluable also for practice with the Morse Light, allowing you to quickly master the Blinker system as used in the U. S. Navy.
We offer the *Omnigraph* as a positive success and with the strongest of endorsements. It has been adopted by the U. S. Government, Department of Commerce, and is used to test all operators applying for Radio licenses. Other Departments of the Government use it for instruction purposes and a large number of the leading Universities, Colleges, Technical and Telegraph Schools throughout the U. S. are satisfied purchasers of the *Omnigraph.* Thousands of individuals have quickly learned with it.



If you expect to enter the Government service, a knowledge of Telegraphy before enlistment will be of invaluable benefit to you, and may mean quick promotion.

Major J. Andrew White, Chief Signal Officer, American Guard, Acting President, National Wireless Association, Editor, THE WIRELESS AGE, says: "The prominent training schools for the past 12 years have found the OMNIGRAPH the one real helper that turns out finished men. The U. S. Government finds the OMNIGRAPH so practical, it places a large number of new machines in use every year."
THE MARCONI INSTITUTE says: "Automatic transmitters for code instruction have been successful, the particular advantage being the uniformity of sending which the student imitates and adopts in his own transmitting. Among the prominent Automatic transmitters are the Wheatstone and the OMNIGRAPH."
The OMNIGRAPH sells at a popular price and is within the reach of all.

If you are a beginner, it will make you an operator in the shortest possible time.
If you are already an operator, the OMNIGRAPH will make you a better one.

Send for free catalog describing 3 different models—$8.00 to $20.00—or order direct through your Electrical Dealer. We sell the *Omnigraph* under the strongest of guarantees—you must be satisfied or your money back.

THE OMNIGRAPH MFG. CO., Immediate Deliveries. **39c Cortlandt Street, New York.**
How did you learn to talk? By listening. JUST LISTEN,—THE OMNIGRAPH WILL DO THE TEACHING

ELECTRICAL SUPPLIES

Wholesale and Retail

Telephone
Madison Square
726

Between Broadway
and Fifth Avenue

CHARLES F. CAMPBELL
14 WEST 31ST STREET
NEW YORK CITY

Concentrate Your Buying

It is easier, better and less costly to buy your tools and supplies from one first class, real, live house that knows how to supply your wants at the right prices.

For years we have made a specialty of tools and supplies.

Advise us your needs—We will supply them.

T.P.WallsTool & Supply Co.,Inc.
75-77 Walker St., New York City
Telephone Connecting all Departments

The Insulation that Stands Every Test

IF you are a manufacturer of electrical apparatus or specialties you need an insulation that can be relied on—a product that will work well under all conditions. The solution of the problem for *those who know* is

BAKELITE-DILECTO

You will find this insulation of particular value in *wireless* apparatus. It's used everywhere by manufacturers who take pride in the quality of their finished product.

Furnished in *Sheets, Rods* and *Tubes.* You will find it waterproof, permanent and strong.

We also manufacture *Vulcanized Fibre* and *Conite* for special insulating purposes.

Let us show you how our Standard Products can be made to solve your insulating problems.

THE CONTINENTAL FIBRE CO.

NEWARK, DELAWARE

233 Broadway, New York City
525 Market St., San Francisco, Cal.
332 S. Michigan Ave., Chicago, Ill.
411 S. Main St., Los Angeles, Cal.
301 Fifth Ave., Pittsburgh, Pa.

Official Italian Photo

In some instances Italian trenches are very different from those on the Western Front, as this photograph discloses; the earthworks are built above ground and then covered over, troops living in the fortified sections

THE WIRELESS AGE

WORLD WIDE WIRELESS

Unmanned Airplane to Be Under Wireless Control

FROM San Diego, Calif., comes a most interesting story of an airplane to be operated by wireless from the ground and to contain freight or bombs but neither pilot nor observer. That the device is not a myth is vouched for by the inventor, Flight Instructor Robbins of the Rockwell Field Aviation School, who hopes soon to demonstrate the practical usefulness of the mechanism. In fact, the inventor claims to have already demonstrated, to his own satisfaction, the practicality of the dual controls, which were placed 12 miles apart and operated perfectly by means of wireless.

If workable in a practical way it would appear that this unarmed craft might be of tremendous value in a definite and restricted line of service. At any rate, it presents a fascinating development of wireless control which ought to add materially to the human understanding of the mastery of the air.

Hun Uses His Wireless to Spread Lies About Americans

THE German wireless, which early in May sent out a despatch alleging that American aviators were crossing to Europe on hospital ships, later reiterated these charges in a longer despatch. The reason for the emphasis placed on this false charge by the Germans, it is pointed out, is probably that they are laying the foundation for justification at a later date of the torpedoing of American hospital ships in case any such ships are put into the transatlantic service to carry home invalided soldiers. Similar charges were spread about British hospital ships as a prelude to torpedoing them. The German wireless message in part said:

"American aviators are crossing to Europe as members of the Red Cross on hospital ships.

"Prisoners openly admit that it is the general practice for aviators to enter the American ambulance service for their passage to Europe and to cross on hospital ships. After they are landed in France they immediately transfer to the Automobile Corps and thence into the air service."

The British Admiralty denied the charge that American aviators were crossing on hospital ships.

Two weeks later, a German wireless message saying that grave insubordination is a daily occurrence in American army training camps was made public by the State Department as an illustration of the lengths to which the German government is going in an effort to keep up the spirits of the civil population.

The message, which was sent out May 9, and which was given out by the State Department without comment, said:

"According to information from Christiania, Norwegians recently arrived from America say that grave cases of insubordination occur daily in American training camps. At first breaches of discipline were punished by death, but this was stopped owing to the number of cases. In a particularly flagrant instance all the soldiers in a camp acted collectively and obtained not only

immunity for the mutineers but punishment for all officers. Furthermore, much damage to works and material is being done."

German wireless messages are sent out for circulation in neutral countries and for the information of German diplomatic representatives abroad. Officials have no doubt that the foregoing statement was given general circulation throughout Germany, as well as in Austria-Hungary.

An Inland Tribute to Patriotic Operators

IF there is any truth in the axiom that the inland man loves the sea most, it may have served as the inspiration for a recent editorial of appreciation which appeared in the Omaha (Neb.) World Herald. The substance of the eulogy follows:

A group of patriots of which very little is said are the Marconi wireless operators. They have a headquarters in the center of the financial district in New York. In those small rooms there are always a number of men waiting for orders. A ship in port never orders a wireless operator until all her cargo and passengers are aboard, and within one hour that operator must be aboard prepared for a voyage through mine fields and zones infested by submarines which will require in most cases weeks of absence. These operators are of all nationalities that are engaged in ocean commerce. They are English, French, Spanish, Italian and from Denmark, Sweden, Norway, Russia, Japan, China, Greece, Holland, Canada, Australia, New Zealand, and all of the South American countries. They receive $80 a month, board and lodging. When they get together it is said that while they speak different languages, each that of his native land, and some of them two or three more, they always seem to understand each other. When they leave the headquarters they have no idea where they are going, but they start on the instant.

Their work is humanitarian, and indirectly they aid the saving hundreds of human lives. Vessels in distress everywhere are aided by them whether they have been torpedoed, overcome by storms or broken machinery. Warnings are sent, calls for help when their own ships are in trouble and many of them have stuck to their posts while their ships were going down until the last man was in the life boats.

Suspected Spy Stations Raided in Chicago

TWO secret wireless stations, one a powerful affair for sending, located on top of a large office building inside the Chicago loop district, were recently raided by operatives from the department of justice. The second was equipped for receiving only and was on the north side.

Investigation has revealed that the "sending" station was powerful enough to transmit messages to Mexico. One man connected with the work, when taken into custody, was found to be registered as an alien enemy.

Two wireless operators were attached to the sending station when Government men raided the office installed on top of the downtown office block. They admitted they had been sending messages for some time, but declared they had no idea where they were sending them.

They insisted they had merely been employed to send and they knew nothing more than this about the affair. They had a knowledge that the stuff they were handling had something to do with Great Lakes, they said. The sending station was rigged up with wires which ran out onto the roof of the skyscraper and were attached to the metal frame of the building to make the necessary "ground."

The receiving station was cleverly concealed in a room on the upper floor of a flat building. Several hundred feet of wire had been rigged up in the room, running back and forth to make the aerial.

Hun Attempt to Destroy Liberian Wireless Plant

FOR the first time since the little African Republic of Liberia declared war on Germany, on Aug. 4, 1917, she has just tasted of the Teuton's wrath.

A German submarine of the largest sea-going type appeared in the port of Monrovia, the capital of Liberia, on the west coast of Africa on April 10, and bombarded the wireless and cable stations there, the State Department at Washington has been informed in an official despatch.

The submarine threw scores of shells from her deck guns into the wireless station, causing extensive damage. She had just turned her attention to the cable office when a steamer was sighted passing the harbor mouth. The submarine left in chase and did not return.

Robert C. Bundy, in charge of the American Legation at Monrovia, sent the news. The first message he sent indicated his belief that the submarine would have no difficulty in destroying all means of communication with the outside world. A later message told of the sudden departure of the U-boat.

Attempt Made to Blow Up Fort Bliss Station

FOUR sticks of dynamite, thirty feet of coiled copper wire and detonating caps were discovered buried under the base of the steel wireless tower at Fort Bliss.

The Fort Bliss wireless station is known as the "motor station" for the Mexican border, between San Antonio and Los Angeles. It receives messages from the wireless station at Southern department headquarters at Fort Sam Houston, and relays them to the smaller stations along the Mexican border. It is said to be the most powerful station on the border.

Substantial Wireless Progress in Australia

WIRELESS conditions in Australasia were interestingly outlined at the Semi-annual meeting of Amalgamated Wireless, Ltd., held at Sydney this year.

The figures in the balance sheet show that the half-year's operations have been satisfactory, and the net profit shows an improvement over the immediately previous half year. The Directors recommended payment of an interim dividend at the usual rate of 5 per cent. per annum. The total reserves have increased since June, 1917, by £2,700 to something over £23,300.

Reference is made in the report to the absence of all revenue from Public Radio-telegrams. This revenue was reasonably anticipated when the company's maritime business was inaugurated, but the war conditions have been responsible for its disappearance. Recovery in that direction will not be possible until shipping affairs reach a settled condition after the war.

Extension in manufacturing and general trading has been very marked, however, during the past twelve months. The demand for wireless apparatus continues, and keeps pace with increased capacity. It is estimated that the number of vessels using wireless service steadily increases, and orders are in hand to equip nearly 20 vessels during the coming year.

Announcement is made of the arrangement with the Wireless Press, Ltd., of London, and the Wireless Press, Inc., of New York, to establish a branch of the Wireless Press in Australia. The main objects of the Wireless Press are to conduct certain news services with the aid of wireless telegraphy, and to issue publications dealing with wireless and allied subjects. Arrangements have already been completed for the Wireless Press, Sydney, to issue a monthly magazine in which a special feature will be made of up-to-date information, and clearly written articles upon the fascinating subject of wireless telegraphy. The magazine will be entitled "Sea, Land and Air."

The company has over 200 persons in its employ, a large majority of whom are Australian born. All employees work in close co-operation and friendship with the management, and fully realize the importance of the work in relation to the war. The seagoing staff exceeds 100 men. A great number of these are frequently employed in the danger zone.

When the Florizel Struck Horn Reef

Story of the Operator on the Newfoundland Steamship—Survivors Owe Their Lives to the Shelter of the Wireless Room, in Which They Spent Two Tragic Nights

By Cecil S. Carter
Marconi Operator

Cecil S. Carter, senior operator aboard the Florizel when she struck Horn Reef on the coast of Newfoundland

I HAVE no doubt many of my fellow operators remember the steamship Florizel as the vessel on which wireless was tested in the ice fields of the North, in its application to the sealing industry. Owned by Messrs. Bowrings, of New York, she was built as an ice breaker and was specially designed for the route that was hers, namely between New York and Newfoundland. This was the run the Florizel had been doing until she met with her fate, which, while not at the hands of the Germans, was perhaps a still more ghastly end, since it involved a loss of ninety-four lives, for she was carrying passengers at the time.

It was at 8 P. M., February 23d, and on a fairly decent night, when the Florizel started on what was to be her last voyage. I took the first trick, while Murphy, my assistant, piped down. All went well during my watch, and when Murphy relieved me at 2 A. M., we were well away from St. John's. After a bit of a talk with Murphy, I slipped off to turn in below, little dreaming how rudely I was to be awakened.

Sleep somehow did not come to me quickly that night, but finally I dozed off into a light slumber. Suddenly I was electrified into consciousness by experiencing the sensation of an awful bump, and this was immediately followed by another and still harder one. The pony wire that was connected to the wireless cabin then started to sing "S O S, S O S, Get up quickly!" And you can believe that I did get a move on in short order. First jamming an O. K. back to Murphy, I jumped into my uniform, pulled on an overcoat and made posthaste for the wireless room. A huge sea met me with staggering force when I reached the deck, but luck was with me, and I managed somehow, by groping my way forward, to reach my destination.

On entering the radio room I found that Murphy had just started the generator going. Instructing him to try to get a position from the Captain, I began to send out the S O S. All the time I was thus employed, I was being thrown violently from side to side in the cabin. I must admit that at other times I have been more comfortably situated while sending emergency calls. Soon Murphy came back and gave me "near Cape Race" as a position. I added this information, with the words "fast going to pieces," to the S O S.

The first signals were sent at 4:45 A. M. on power. After one heavy sea the lights went out and then I reverted to the auxiliary set and utilized it for a period of about five minutes. Then came one tremendous smash as a heavy comber struck the cabin, swamped my storage cells and put the

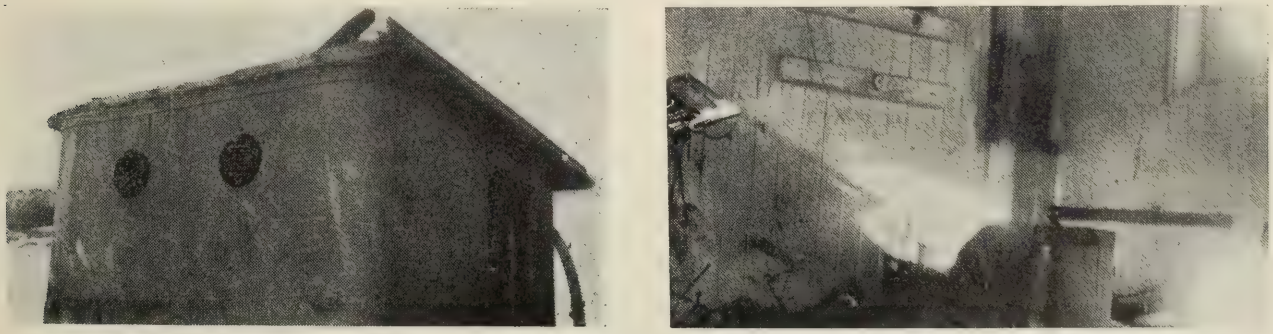
whole set out of commission. A few seconds later Murphy called to me that the topmasts and aerial were down, and I rushed out of the wireless room into the face of a vicious and spiteful comber. It completely swamped the decks and smashed our boats over the side in a moment, and away they flew. There came a yell from somewhere for everybody to hold on fast. A few of us clung to the lee rail by the wireless room, and a Turkish bath was not in it with the drenching we went through.

Shortly after this—it might have been a half hour at that—one of our group suggested getting into the wireless cabin, seeing that it had withstood so much battering. It appeared reasonable to believe that it would keep together for a while longer, so we all worked our way into the steel house. Three others had hastened there before us. By degrees stragglers came in and the room filled up rapidly. One of the last comers brought us the intelligence that the bridge had gone and also the Captain's room, and then another arrival informed us that the smoking room had been swept away. Later information proved these assertions to have been correct, and to our grief we learned that in these accidents fifty souls had been swept into eternity.

Meanwhile things began to quiet down a bit, and we in the cabin had an opportunity to consider our surroundings. There we were, about forty of us, in a compartment eight feet square, all of us wet and sodden, many half-clothed, the radio room leaking through the roof and the seas flooding us at short intervals. Some of the members of our party had suffered broken limbs, and our third mate had his face fearfully bruised, but there were no groans or complaints to be heard. All realized that we must wait and trust for the best to happen. Hour after hour passed. Fortunately daylight was not far away, seeing that we had struck Horn Reef off Broad Cove at 4.45 A. M., Sunday, February 24th.

The coming daylight gave us a bit of cheer, but the seas continued to pound fiercely against our little refuge. But the walls of the wireless cabin held out bravely, and on the pounding somewhat abating, we could get a glimpse through the portholes of people grouped on the shore but evidently helpless to bring aid to us. One little boat which had been spared by the combers tried to put over, but capsized, so that attempt to reach shore had to be abandoned. The dreary hours crawled slowly on, but towards evening our spirits were again cheered by the sight of a couple of small steamers on the horizon.

But unfortunately, the evening drew in quickly and darkness settled down, and we were disappointed to observe the craft drawing off for the night. As I learned afterward, the men on the steamers thought there were only four persons left alive aboard the Florizel. It also came to my knowledge afterward that my S O S was received by Cape Race and by the Pearl, a Government steamer, which latter ship managed to have the message telephoned to the owners' agents in St. John's, where the news of the disaster was received approximately at 5:54 A. M., on Sunday. We ourselves had received no signals, owing probably to the shortness of the time between



Exterior and interior view of wireless room, size 7x8 feet—34 lives were saved through the protection afforded by this steel structure

the striking of the reef by the Florizel and the flooding of the wireless room by the combers which put the apparatus out of commission. Indeed, I tried once to receive, but apparently the steamers that were attempting to transmit to me had their signals crossed. At that my attempt at receiving lasted only a few seconds, and the approximate time the set was used consumed in all ten minutes.

Meanwhile we were packed in the cabin, compelled to keep another night's vigil, the discomforts, if not perils of our situation becoming more aggravated as the hours passed. We were beginning to suffer severely the pangs of hunger and thirst, especially the latter, for no water was available. The men were able to solace themselves a bit with a small portion of tobacco, but even this small comfort was denied two women who were in the cabin, whose pluck and powers of endurance compelled the admiration of all the rest of us. It seems even now inconceivable how these two poor women survived the ordeal of that second night, clad in night dresses, over which they had flung thin jackets, just as they had run from their cabins when the Florizel struck. Their light clothing gave them small protection in the small room from which the door was gone, a sea having wrenched this small protection from its hinges during the morning hours. Still we kept huddled in the room, waiting for rescue, packed so closely that we were unable most of the time to move our arms.

On Sunday afternoon one poor fellow gave up, and we were compelled to lay his body outside on the deck. This was done gently and reverently, and shortly afterward he was carried from sight by a sea. This poor chap was a returned soldier and had lost his wife and child earlier in the day. The time dragged on, and in the attempt to cheer ourselves up a bit we began to sing "Nearer, My God, to Thee" and also "John Brown's Body." The singing tended to raise our spirits somewhat, although our voices sounded very tremulous and pathetic in the stillness of the night. Others of our party then began to lift their voices in "The Rosary," which obtained a good response. In this fashion the greater part of the night passed away.

Toward two o'clock on Monday morning we sighted a well-lighted ship, and one or two of us having torches in our possession, we at once began to make attempts to communicate with this vessel and several other rescue ships which came into view now and then. In this our efforts were success-

Views of wrecked Florizel. Left—Bow looking aft. Note inner stack jammed up. Center—On Horn Reef breakers on calm day. Right—Crushed side and music room looking forward

Steamship Florizel as she appeared before and after the wreck

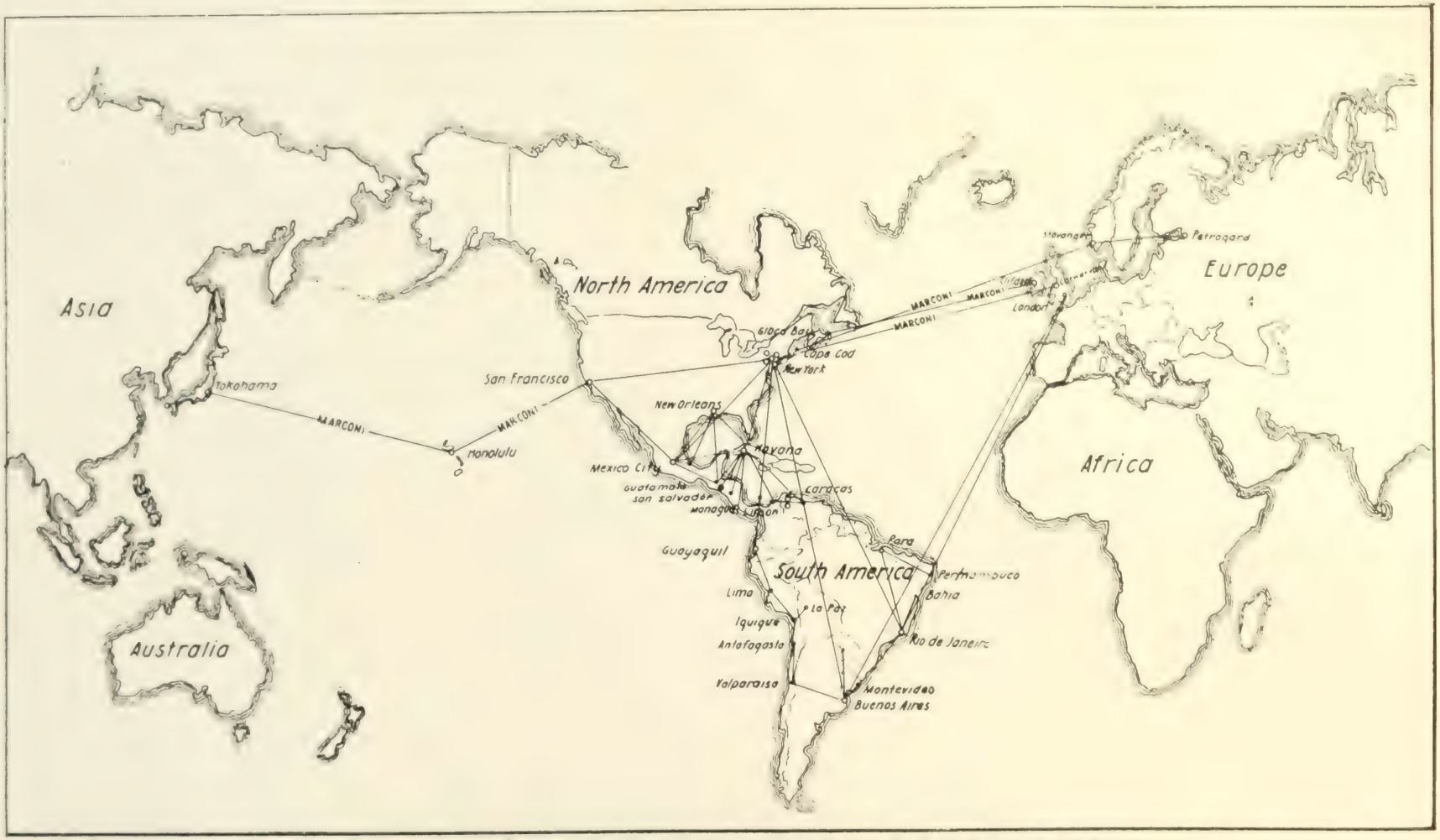
ful, and we then learned that the persons on board the ships were surprised to hear of the number of refugees who were crowded in our small cabin. They informed us that they had attempted to get a boat off to us, but that it had capsized. They added that they would make every effort to succeed in rescuing us in the morning or at least by daybreak. After I had interchanged a few more messages with the ships, I shut the porthole. I had been signaling through this porthole with the torch. When I told the news to my fellow sufferers, they appeared greatly relieved and even cheered.

With the break of day the work of rescue was begun, and I can assure you that it was no easy matter in that rough and tumultuous sea. But the men in charge of the boats were brave and enterprising fellows. They anchored a jolly boat a few yards from the Florizel and thence passed a line to a position near the wireless house, so that the small dories which now approached could maintain their positions in the turbulent waters. Our survivors on board the Florizel were compelled to make a jump for it, and if they landed in the dories they were considered lucky. Those who missed their footing received a cold plunge.

However, once we were finally gathered on board the rescue ships, we obtained the life necessities and the creature comforts from lack of which we had undergone such suffering. We were placed in warm blankets and fed, and the injured members of our party received at least emergency treatment and attentions. We arrived in St. John's again about five hours later, where a great crowd of friends eager to assist us were gathered on the pier. Ambulances and doctors were immediately told off to attend to the survivors and take the wounded to the hospital, while many were cared for by private friends, and members of the crew in some cases, going to the Institute for Seamen.

In all ninety-four persons lost their lives in the Florizel disaster, that number including one of the leading members of the shipping company to which the liner belonged. Among the lost were several prominent residents of St. John's and also an American citizen. A total of forty-two persons were saved, of which thirty-seven owe their lives to the staunch little wireless room in which they had taken refuge on board the wrecked steamship. Amongst the officers who were lost was the chief engineer and the second mate, the latter an old man of sixty-seven years, but yet very bright and spruce. Both of these men had been in the service of the steamship company for more than thirteen years and were well liked and widely known.

The wrecking of the Florizel is an experience such as few of those who survived the catastrophe can ever forget. It was an odd coincidence that my wife was on board the Florizel's sister ship, the Stephano, when the latter was torpedoed off Nantucket a couple of years ago. This was the time when five other ships were sunk by the U-53. I may add that both ships proved themselves game to the last, owing chiefly to their having been so strongly built.



The projected Pan-American Wireless Chain showing how it is to be linked up with all Continents

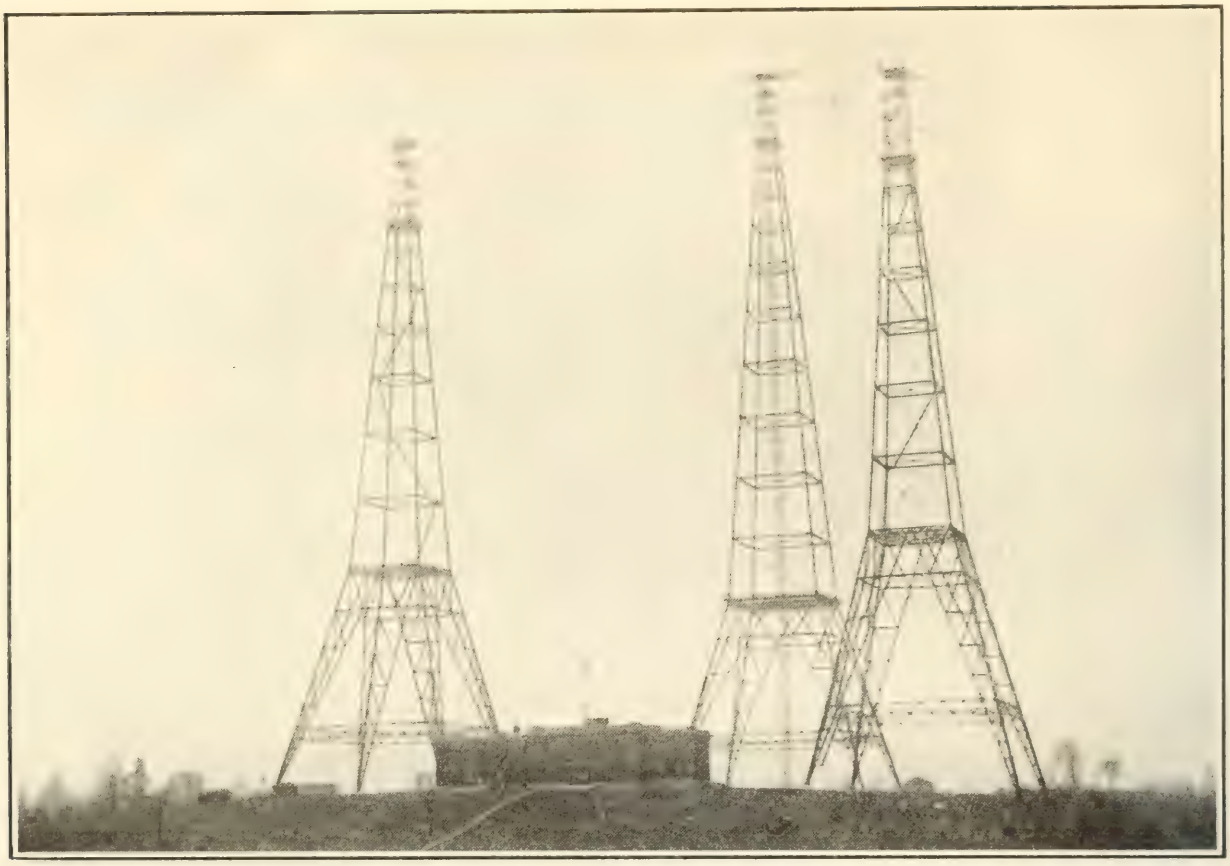
The Pan-American Wireless Chain

The First Practical Step Towards Linking Up the Americas by a Direct System of Wireless Telegraphy

THE recent announcement that the largest wireless station in the world is to be erected near Buenos Aires, heralds the advent of a revolutionary step in communication with South America. It is stated that 11,000 kw. power will be utilized in the new station and the aerials will be suspended from three towers equal in size to the famous Eiffel Tower. Pan-Americanism being based upon the principles of common interest, the Pan-American Wireless Telegraph and Telephone Company, which is to undertake the construction, thus signalizes the most practical step yet taken to develop and extend the trade and general relations of all the countries of the Americas. To convey an adequate idea of the importance and value of this enterprise, it is necessary to describe its objects and to indicate, in some measure, the enormous advantages that will necessarily follow their attainment.

The main purpose of the Pan-American Company is to connect the United States with the whole of South America by means of wireless communication. It will begin with Argentina, Brazil and Uruguay and continue to Chile, Peru and Ecuador, in the order named, arrangements also being made to include Mexico and Cuba contemporaneously with the work in Brazil. In the United States the system will connect with the Western Union land lines, this being in direct connection with over 25,000 telegraph stations. The South American wireless system will connect at New York with trans-Atlantic wireless to Great Britain, Scandinavia and Russia; and at San Francisco with the Hawaiian Islands and thence with the Orient. Arrangements will also be made with the different governments for an exchange of messages over the government telegraph lines, with official authority to the company to maintain its own main offices in the larger cities. It is likewise contemplated to erect stations in the Central American Republics. The fulfillment of this comprehensive program will be greatly facilitated by the adoption of the latest inventions in wireless telegraphy, including the rights and patents of the American and English Marconi Companies and of the Danish Poulsen-Pedersen system. These, in brief, constitute the immediate plans of the new company, whose president is Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, who had a large share in establishing wireless communication between the United States and Japan by way of the Hawaiian Islands and in building the system that placed the Pacific Coast stations in direct communication with Alaska.

There have been many existing physical obstacles to a proper development of the inter-American commerce, and not the least important of these hindrances to closer trade intercourse amongst the various Republics is the lack of a cheap and rapid system of telegraphic communication. The need for additions to the services operating on the American continent has long been felt by big business. Difficulties resulting from the absence of this important adjunct of commerce were authoritatively expressed during the sessions of the Pan-American Financial Conference held at Washington in May, 1915. At that Conference, which was attended by the President of the United States and members of his cabinet, as well as by the most influen-



It is understood that the lofty towers from which the aerials will be swung in the South American station will be of the self-supporting type, somewhat similar to the Arlington towers here illustrated

tial representatives of all the American governments, there was hardly a speech or a report of an individual or group which did not contain some reference to the urgent necessity for improved telegraphic service between the two Americas. In the official letter addressed by the Secretary of the Treasury to the foreign delegates, on the work of the conference, the following question occupied a prominent place:

"What difficulties exist in the way of direct cable communication between your country and the United States? Give comparison of cable rates between your chief city and New York City, London, Berlin, Paris and Rome."

All the group reports contained the unanimous recommendation of the Conference that the rates of American companies should be on a par with European rates and that each government should seek to have installed a wireless system from country to country; and in the important address delivered by Secretary of Commerce Redfield, the question of telegraphic rates and service was featured as one of the most vital problems in the effort to establish closer relations among the American Republics.

"We think it should be made a matter of care that your great commercial centers should be connected with those of all the world on an equal basis," he said. "It should be as cheap and convenient for you to communicate from your cities with ours as with those of Europe. At present it is possible for you to cable from some of your cities to European points at a considerably less cost than to our own, and in some cases the difference is striking. Without knowing how far this matter may be within the direct control of your several Governments, it seems to me that a sound policy can be laid down on this subject in this way: It should be as easy and as cheap for all America to communicate with itself as it is for it to communicate with lands across the

sea. There ought to be no handicap of telegraphic rates between American countries in favor of European ones. We of America are in a sense of one international family, and we should see to it that the family is not at a disadvantage in this important respect. There is another thing incidental to what I have said, greatly needed in South and Central America concerning us of the north, and that is some systematic and reasonably accurate news service which shall not publish throughout all our sister nations the small and the narrow and the poor and the bad exclusively. I have discussed this important question with the managers of our leading press associations, and they deplore it, but find themselves for the moment helpless concerning it. There is no direct cable communication now, they tell me, for press dispatches, for example, with the cities of Buenos Aires and Rio de Janeiro, and I feel that we suffer in the eyes of our brethren at the south for lack of a truthful picture of us presented every day in the columns of the daily press in the cities of Spanish America."

In the letter to the President of the United States from the Secretary of the Treasury, transmitting the proceedings of the Conference, Mr. McAdoo wrote:

"Another subject of very great importance is the need of direct cable communications and reasonable rates between the Latin American countries and the United States. This was emphasized by many delegates in the Conference. There is no doubt about the disadvantages under which all of the countries of Latin America and the United States labor on account of the present roundabout and unsatisfactory facilities and the excessive cost of cable communication between them."

Among the reports of the General Committee on Transportation and Communications, prepared in each case by representatives of all the countries, the following two, referring specifically to Argentina and Brazil, are almost identical with the reports of other delegations. The report on Argentina regarding this question contains the resolution:

"Whereas, in view of the great distance and slow mail facilities existing between the Argentine Republic and the United States, the matter of quick

Typical power plant of a Marconi long-distance station, showing aerial wires leading in

communication between the two business communities is of vital importance to the development of trade,

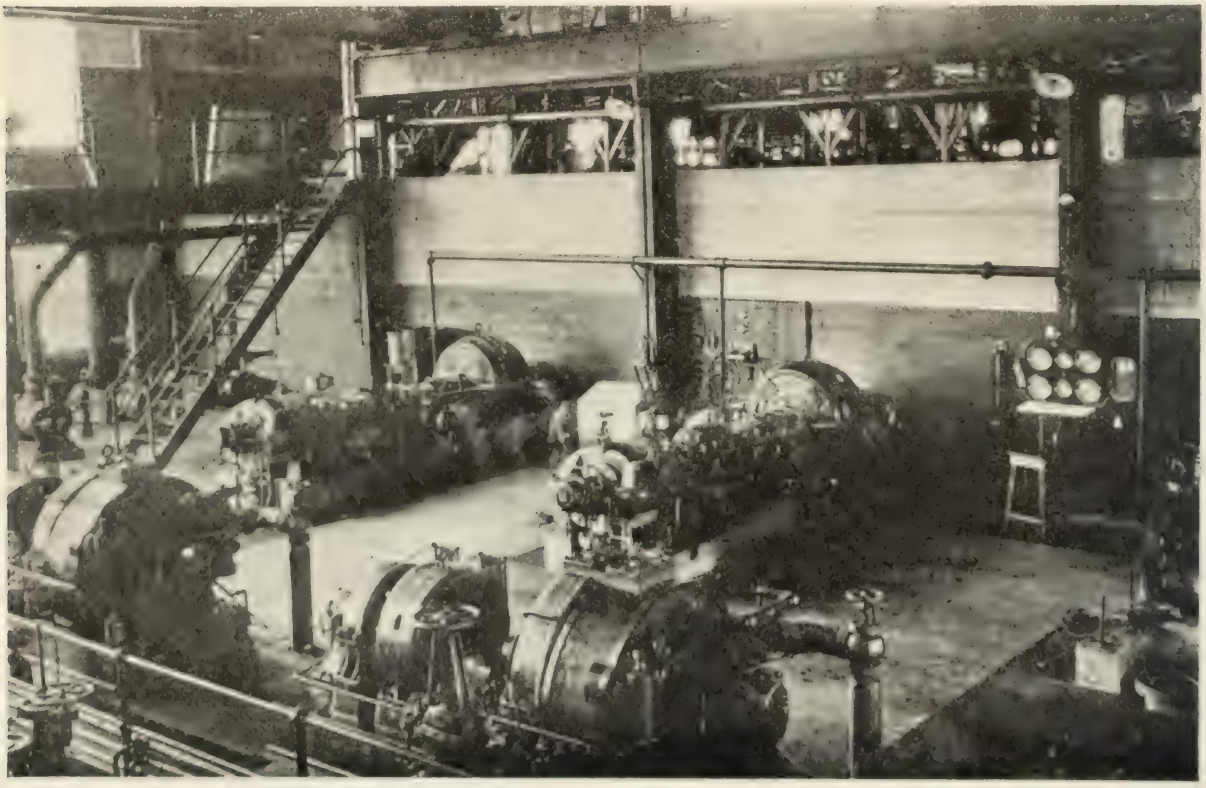
"Now, therefore, be it resolved, that this conference bring to the attention of the Governments of both nations the need for cheaper telegraphic communication and that they be urged to take any proper and necessary action tending toward the establishment of lower rates for direct telegraphic communication in co-operation, when desirable, with other Latin American countries."

The recommendations of the Brazilian Committee still further emphasized the importance of the subject by direct and specific proposals of the very nature contemplated by the Pan-American Wireless Telegraph and Telephone Company. That committee's views were embodied in two significant paragraphs:

"We urge the extension of direct telegraphic service, either wireless or cable, between all parts of North, Central and South America, to be owned, controlled and operated by exclusively American interests.

"We recommend to the press of all the interested countries that a more comprehensive and reliable system for the exchange of important news items be established."

These passages from the official speeches and documents not only express with high authority the true needs of the prevailing situation, but they also assure the complete and hearty co-operation of all the American Governments in the furtherance of the great work undertaken by the new company. Every one of the points urged by the authorities quoted is embraced by the plans of the company. By reason of high-speed operation and favorable rates it is also proposed to offer inducements to newspapers and press associations to send and distribute reports and dispatches of greater length and with greater frequency than is possible under present conditions; and, as a result of such improved facilities, to bring about a generous interchange of news dispatches between all the different countries, thereby enhancing their friendly relations as well as serving their trade interests. Further develop-



Interior view of a Marconi power plant for trans-ocean stations, illustrating the magnitude of the task of linking up the Americas

ments contemplated by the Pan-American Company also include the transmission of night and week-end letters at greatly reduced rates, a service which has proved very popular in trans-Atlantic and trans-Pacific wireless telegraphy, and other innovations of a like character. Another sphere of operation to which the company's service will extend is, as its name indicates, that of wireless telephony, which is being developed with remarkable rapidity and success; and there is little doubt that within a measurable distance of time an important part will be played by that method of communication in long-distance messages as well as from ship to shore. There is also a wide field for a use of the wireless telephone for vessels too small to permit of carrying an operator for wireless telegraph communication. Equipped with a simple wireless telephone, the operation of easily communicating with lightships, shore stations and passing craft could be conducted by any of the ship's officers; and with a view to the early introduction of this branch of the service the company has acquired new inventions which will add considerably to the speed, the selectivity and the secrecy of the service.

The organization of the Pan-American Telegraph and Telephone Company has been effected under the most favorable conditions with every moral and material guarantee for the fulfillment of the important objects it has undertaken to accomplish. It is strengthened by the capital and large resources of the Marconi Wireless Telegraph Company of America, and its engineering and technical staffs include a number of the leading experts in wireless telegraphy, some of whom have brought about the many improvements in the trans-oceanic stations. It is even still more encouraging to note that the company expects that the first important step of establishing direct wireless communication between New York and Buenos Aires will be completed within twelve months. Thus, it is safe to assume that the final realization of an all-American system of wireless communication will eventuate within a shorter time than was ever thought possible by the representatives of the various American Republics who so strongly pressed the idea two years ago. The fact that the task is one of no light order may be gathered from the accompanying illustrations. Even these do not convey an adequate impression of the elaborate and delicate machinery, extensive plant and construction required for the proper equipment of high-power stations for long-distance wireless service; and when it is considered that suitable sites have to be located and acquired, each of which must be provided with a sufficient area to permit of the erection of the various buildings and steel masts, the completion of the South American service abundantly demonstrates the measure of the company's resources and capacity.

The Wireless Age for September

will contain among other features a full description of a new

"Spark Discharger for Radio Frequency Oscillation Circuits"

which is adapted for use under conditions of constant vibration, sudden shock, change of position and conditions usually encountered in the marine service and aboard warships during heavy gun fire.

Another interesting article relates the

"Advance Made in the Design of X-Ray Tubes"

by controlling the area of the focal spot or surface so that the length of the focus of the cathode rays are varied at the will of the operator.

WINDSOR CASTLE.

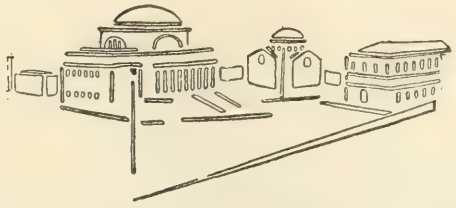
Soldiers of the United States, the people of the British Isles welcome you on your way to take your stand beside the armies of many Nations now fighting in the Old World the great battle for human freedom.
The Allies will gain new heart & spirit in your company.
I wish that I could shake the hand of each one of you & bid you God speed on your mission.

George R.I.

April 1918.

The letter of welcome from King George of England, a facsimile copy of which was given to every American soldier arriving in Great Britain

Progress in Radio Science



The Use of Telegraph and Telephone Lines

IF a radio frequency current is induced in an electrical conducting circuit of inordinate length, there will be nodes and loops of potential at various points along the wire. If a voltage-operated radio receiving detector is connected to this conductor at the point where the voltage is maximum, response will be obtained from wireless transmitters.

An apparatus has recently been shown by Elmer E. Bucher wherein telephone, telegraph, or power-line conductors can be employed as collectors of radio frequency energy, and by associating therewith an open circuit oscillator such as shown in the accompanying drawing, figure 1, radio signals may

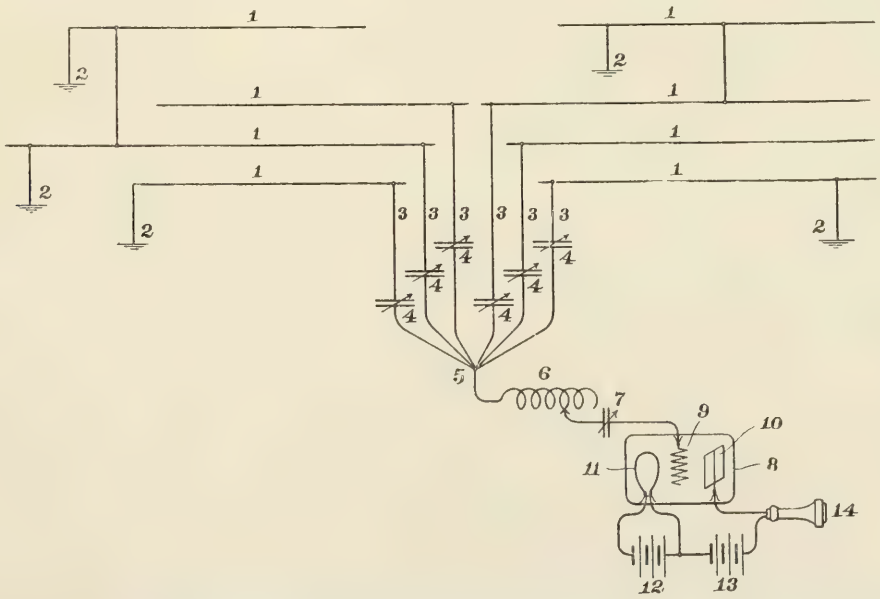


Figure 1—Diagram showing telegraph, telephone or power-line conductors as collectors of radio frequency energy

be received over considerable distances. In the diagram, telephone or telegraph conductors are shown at 1, being earthed at the point 2. In order not to interfere with the carrying on of telegraph or telephone communications they are connected together through condensers of small capacity joining in a common terminal at 5, and ending in the coil 6, the variable condenser 7, and the grid element 9 of a three-electrode valve. It is not necessary in a system of this kind that the conductors 1, be tuned to the periodicity of the incoming oscillations, but it is essential that the circuit 6, 7, 9, have a natural frequency of oscillation equal to that of the incoming signals. By proper adjustment of the condensers 4, it is possible in this circuit to cause a loop of potential to take place at the free end of the coil 6, and therefore upon the grid element of the valve 9.

Novelty in Spark Design

A FAVORITE form of impulse excitation transmitter is the one employing a multiple gap. It has been shown that in order to bring about excitation by impulse of an oscillating circuit, it is advisable to use multiple spark gaps

with a very short discharge gap and a number of spark gaps in proportion to the voltage brought into play. The impulse effect, in general, is more accentuated with short discharge gaps.

Various designs have been laid down from time to time for the construction of such spark dischargers, but many lead to excessive heating, either in consequence of the enclosure of the gap or as the result of the shape of the electrodes. In respect to the latter, their design may not permit the continual displacement of the sparks on the surface of the electrodes.

The method of construction recently described by E. Guardeau and J. Bethenod, shown in figure 2, greatly facilitates the cooling, and at the same time simplifies the construction.

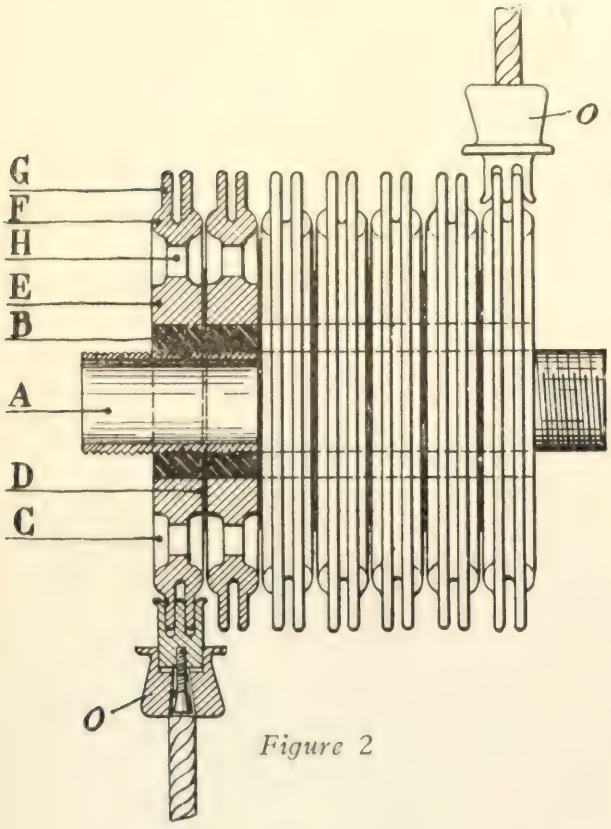


Figure 2

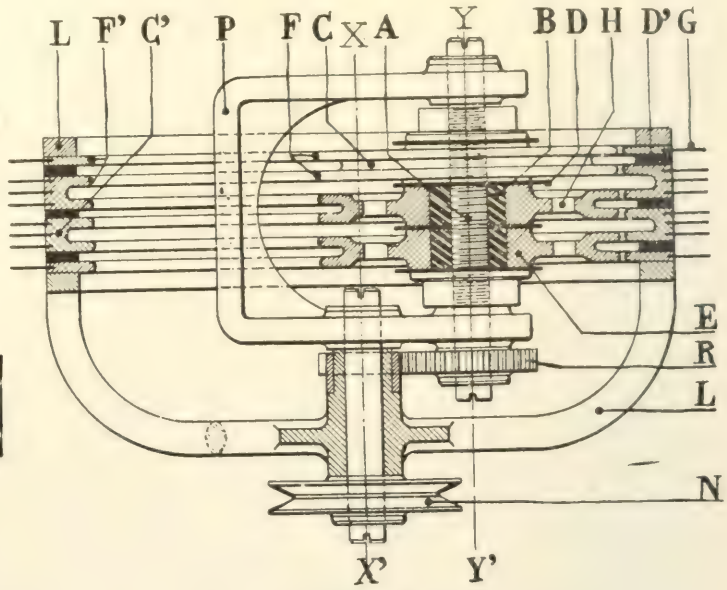


Figure 3

Figure 2—Simplified construction of spark gap for high powers with improved cooling facilities

Figure 3—Spark gap employing a form of rotary gap to cool the electrodes

In this figure, A is a plain hollow cylinder of hard metal, on which are threaded rings of insulating material B; on the latter the electrodes fit snugly and a mica washer D of very accurately gaged thickness is placed between two consecutive rings B; finally, the electrodes C are constructed in the form of disks comprising a hub E and a double swelling F, the axial thickness of which is equal to that of the hub E and of the ring B.

Constructed in this way, the sparking distance between two consecutive electrodes is equal to the gaged thickness of the washers D, and the spark discharges between the swellings F opposite the two consecutive electrodes, the external diameter of the washers D being of the proper thickness to prevent any sparking between two adjacent hubs.

Since the adjustment of the various parts is easy and may be effected with very great precision, it being assumed that one is only concerned with tuned parts, the exact parallelism of the electrodes is insured, and the spark discharges throughout the active surface of the electrodes.

In order to insure the cooling of the electrodes, which is indispensable to the satisfactory working of the spark gap, the latter terminate in vanes G. They also are pierced with several holes H, through which air circulates. The ribs G serve at the same time as a connection to the external circuit, permitting any number of gaps to be employed.

While the spark gap shown in figure 2 may be employed for high powers,

it is advisable to employ some form of a rotary gap embodying the foregoing principle. This prevents consumption of the electrodes. The construction shown in figure 3 satisfies the above mentioned requirements.

In this spark gap half the electrodes are fixed and the other half are movable. A metallic frame L supports the fixed electrodes C^1, which are in the form of rims and carry two swellings F^1, which constitute the active surfaces. These electrodes are provided with vanes G to insure the cooling thereof, and are insulated from one another by washers of mica (or other insulating material). This is indicated at D^1. The plates are then pressed against one another by any suitable locking device. The mounting of the movable electrodes is exactly the same as that shown in figure 2. They are supported by a shaft A, on which are fitted the insulating rings B. On the latter are fixed the electrodes C, which are insulated from one another by mica washers D.

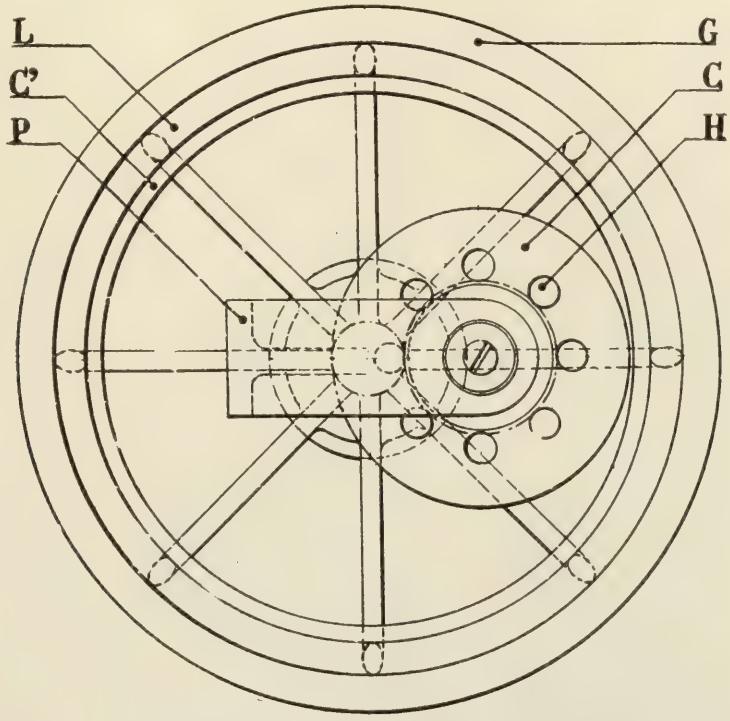


Figure 4—Plan view of the spark gap

The shaft A may be rotated by a system of gearing H controlled by a pulley N, which makes the entire system rotate about the axis XX^1 and at the same time makes the shaft A rotate about the axis YY^1. In this way the points of discharge of the sparks are continually renewed, which insures proper cooling. Figure 4 is a plan view of the spark gap.

A Spark Gap Designed to Reduce Resistance

A SPARK discharger designed to reduce resistance between electrodes by introducing a highly ionized gas between them has been described by William Walker Strong. An object of his invention is to produce unidirectional currents, from an alternating current by introducing a surface giving off ions of a definite single sign in the alternating current circuit.

A further object is to present a method of destroying or preventing an oscillatory discharge between spaced apart electrodes when the current between the electrodes is started or stopped.

It is well recognized in the art that the presence of ions in a gas between spaced metallic electrodes serves to carry the current between the electrodes. If these ions are free to move and are sufficiently numerous they will cause the difference of potential between the electrodes to be decreased. In other words, the presence of these ions makes the gas a conductor, and the con-

(C) Comm. Pub. Info.

The oft-repeated query as to whether the Marines have a Signal Battalion is answered in this picture of a radio section of the "Teufel Hunden" taking down military messages in France. Those among this magazine's readers who are anxious to take the trip overseas with the Marine Corps may note that the home station of the Signal Battalion is in Philadelphia, where a training school is maintained, Major J. J. Meade, commanding, who endorses the statement that just now unprecedented opportunity is given applicants experienced in radio or wire telegraphy. An invitation to write Major Meade personally is cordially extended to all prospective applicants

ducting property of the gas will depend upon the density and number of ions; the value of their electrical charge; and the ease of mobility with which the ions move. Since electrons are at present generally recognized as the smallest ions, they are therefore better able to satisfy the above specified conditions, and consequently are better carriers of the electric current than any other known kind of ion.

Strong's method of decreasing resistance between gap electrodes consists in producing a large number of ions, possessing as high a mobility as possible, between the electrodes at times when the electric current is flowing between the electrodes. On account of their mobility, it is obvious that the production of electrons is preferable to the other kinds of ions. Many kinds of ionizing agents may be used for this purpose; for example, the ions may be produced by radiations from radio active substances; from electrical discharges, such as the well known X-ray, and other rays of this character; or from incandescent bodies.

For many purposes the use of incandescent bodies is preferable for carrying out the method, because incandescent surfaces are easily produced or obtained and the ionization is localized near the surface of such a body.

The ionization of a gas near the surface of an incandescent solid depends upon the temperature of the solid; the nature of the solid; the condition of its surface; and the value of the electric and magnetic fields in the region where the ionization is being produced. There are two types or kinds of ions, that is, positive and negative ions. It is well established that the positive ions are of molecular magnitude or larger, while the negatlve ions are much smaller and often electrons. By suitably selecting the temperature, the condition of the incandescent surface, the values of the electric or magnetic fields, the relative and absolute number of positive and negative ions may be controlled or modified. By suitably arranging conditions to produce ions of substantially one sign only, it is possible to obtain a uni-directional current from an alternating current acting between electrodes, for the reason that if an electrode is giving off ions of a single sign it will assist, or at least not resist the current flowing in one direction, but will greatly resist the flow of the current in the opposite direction.

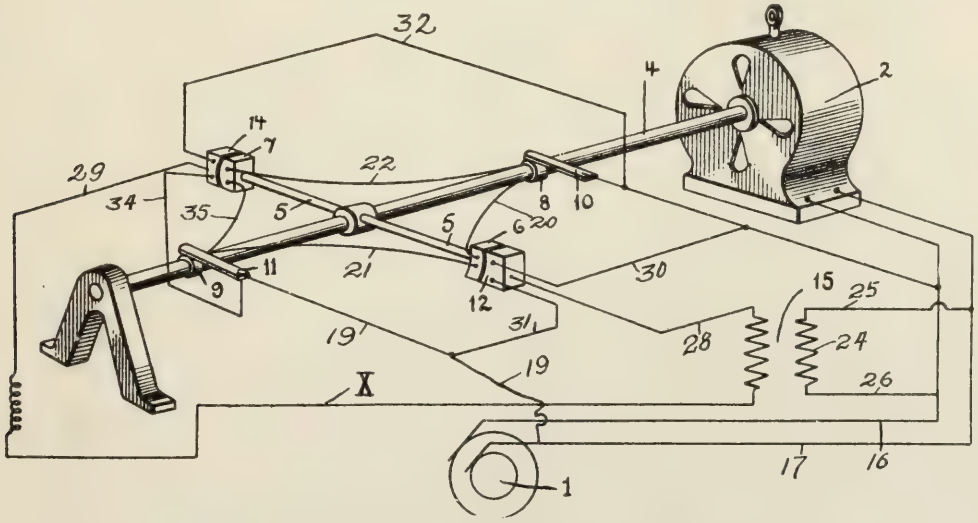


Figure 5—Spark gap designed to reduce resistance

There are several means by which a solid may be raised to incandescence. For example, a beam of radiation such as heat may be focused upon the solid; the solid may be heated by an electrical current, or it may be placed in or near the region where a chemical reaction of great heat producing power is taking place. A concrete case of the latter type is the raising of surfaces to incandescence by means of surface combustion. Surface combustion consists in the burning of a homogeneous mixture of two gases such

as air and illuminating gas (in proper proportions for complete combustion) without flame, in contact with a granular incandescent solid whereby a large part of the energy of combustion goes to heating the incandescent solid. For example, the mixed gases may be admitted to the rear of a porous granular diaphragm of heat resisting material and the mixture fired as it comes through the pores of the diaphragm. As soon as the diaphragm becomes hot the combustion takes place entirely within the granular diaphragm without flame and the outer surface of the diaphragm becomes very hot, while the inner surface may be kept comparatively cool dependent on the speed of the incoming gas. By this method very high temperatures may be obtained.

Figure 6—A portion of an alternating electric wave

One form of this apparatus is shown in figure 5 and in figure 6 a portion of an alternating electric wave that is transformed into an intermittent uni-directional current by the use of the apparatus and method diagrammatically shown in figure 5.

Another form of apparatus shown in figure 7 permits an alternating current to be resolved into two intermittent uni-directional currents.

Figure 8 illustrates the portions of an alternating current which are transformed into uni-directional currents by means of this system.

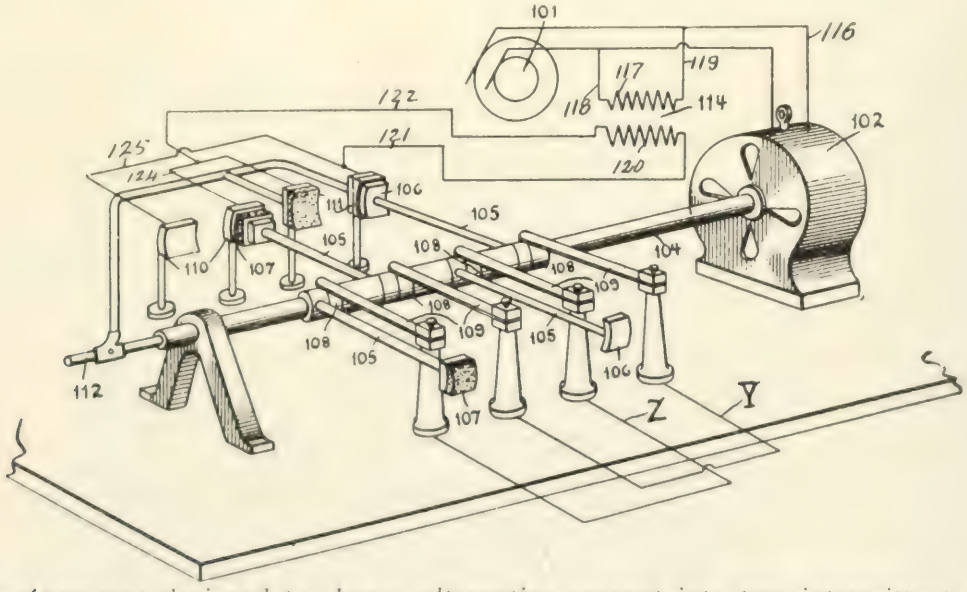


Figure 7—Apparatus designed to change alternating current into two intermittent uni-directional currents

Figure 9 illustrates one form of electrode which may be employed to carry out the objects of the invention.

Referring to figure 5 in which all of the parts or elements are diagrammatically represented, the alternating current generator 1, which is a source of supply, is directly connected to a synchronous motor 2 by means of the conductors 16 and 17 in such a manner that the motor will run in synchronism with the generator. A driver shaft 4 is properly mounted in suitable bearings, and carries a metallic conducting arm 5. On the outer ends of this arm are mounted electrodes 6 and 7. Each of these electrodes is provided with an outer surface capable of being heated to incandescence by means of a small electrical furnace contained within the electrode. The current to the electrical furnace being furnished through collector rings 8 and 9, by means of brushes 10 and 11. The brush 10 is connected by the conductor 18 with the main feed wire 16 and the brush 11 is in like manner connected by means of

the conductor 19 with the main feed wire 17. The conductors 20 and 21 connect the heating element in the electrode 6 with the collector rings 8 and 9 respectively thus completing the circuit to supply the current to heat the electrode 6, and the conductors 22 and 23 similarly connect the collector rings 8 and 9 with the heating element in the electrode 7. Stationary electrodes 12 and 14 are provided with inner surfaces which may be also heated to incandescence by means of electrical furnaces, the currents of which may be supplied in any suitable and proper manner. For example, the heating element in the electrode 12 may be supplied with electricity through the conductor 30 connected with the lead 18 and the conductor 31 connected with the lead 19, while the heating element in the electrode 14 may be supplied with electricity through conductors 32 and 34 connected to the leads 18 and 19 respectively. A transformer 15 is arranged with its primary 24 connected with the generator by means of the conductors 25 and 26 and its secondary 27 connected by means of the conductors 28 and 29 with the stationary electrodes 12 and 14 respectively, thus forming a circuit X, the intermittent unidirectional current of which may be utilized for any desirable purpose.

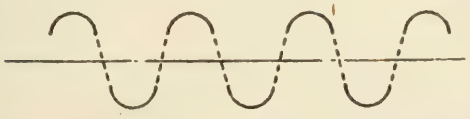


Figure 8—Showing portion of alternating current which is transformed into uni-directional current

Figure 9—Form of electrode employed in apparatus

To put this apparatus in operation the transmitting surfaces of the moving and stationary electrodes are raised to incandescence; the synchronous motor 2 is run in step with the generator so that the moving electrodes are passing the stationary electrodes when the alternating wave has reached its crest on the positive side. Since the electrodes are very highly heated, any gas near their surfaces is in a high state of ionization, and therefore when the moving electrodes pass near or over the stationary electrodes, the incandescent surfaces of the stationary electrodes and the moving electrodes are brought very near together and the spaces between these electrodes are filled with a highly ionized gas. Consequently resistance to the passage of the electricity between these points is very greatly diminished.

Figure 7 shows a mechanism wherein certain of the electrodes comprise surfaces of combustion. In this figure the diagrammatic representation of an alternating current generator 101, which is the source of electricity, is directly connected to a synchronous motor 102 by means of the conductors 115 and 116 respectively, which rotates a drive shaft 104. The drive shaft 104 is properly mounted in bearings and carries a plurality of metallic arms 105, upon the outer ends of which are mounted metallic electrodes 106 and surface combustion electrodes 107. The drive shaft 104 is hollow up to the arm carrying the second electrode provided with a surface combustion plate. The arms for the surface combustion electrodes 107 are also hollow tubes and serve as conductors to lead a proper combustion mixture to the electrode surface combustion faces. Each of the moving electrodes is electrically connected with its respective collector ring 108, which are all insulated one from another, and each collector ring is provided with a brush 109. There are stationary electrodes provided for each movable electrode, and metallic stationary electrodes 110 are provided to co-operate with the movable surface combustion electrodes 107, and stationary surface combustion electrodes 111 are provided to co-operate with the movable metallic electrodes 106. A proper combustible gaseous mixture is fed to the surface combustion electrodes by any convenient means, such as for example, the supply pipe 112. A transformer 114 is arranged with its primary 117 connected by conductors 118 and 119 to the generator, and its secondary 120 is arranged with each end

respectively attached to a metallic stationary electrode and also to a surface combustion stationary electrode, by means of the conductors 121 and 122 which connect with the conductors 124 and 125 that are each respectively connected to a stationary metallic electrode and to a stationary surface of combustion electrode.

The brushes 109 are connected in circuits Y and Z in such manner that as the synchronous motor 102 runs in synchronism with the generator one circuit will be completed when the alternating wave has reached its positive crest and the other circuit will be completed when the alternating wave has reached the negative crest, thus the result will be two independent unidirectional currents, one over the circuit Y and the other over the circuit Z. It will be noted that the surfaces of combustion are all so arranged that the current each time leaves the surface in the same direction. For example, figure 7 is shown with the circuit Y as being excited. The current enters the stationary surface combustion electrode 111, passes into the movable metallic electrode, completes the circuit through the brushes and outer circuit, leaves the movable surface combustion electrode 107 and enters the stationary metallic electrode 110. In each case it will be noted that the current passes from a surface of combustion into a metallic electrode.

Protection for Wireless Aerial in the Submarine Zone

THE present war has brought forth some curious yet highly practical inventions. Explosions in vessels, due to torpedoes or contact with floating mines, etc., have put ships' masts supporting the wireless antenna to such strain as to break the aerials and to prevent calling for help. We are informed by the "Telegraph and Telephone Journal" of England, that a patent has recently been granted by the British Government to Mr. S. Hall, for a device which reduces to a minimum the risk of wireless aerials on vessels being broken and the wireless apparatus thus put out of connection. The invention utilizes one or more long extension springs, specially constructed and fitted at each end of the present aerial. These springs automatically expand and contract to allow the aerial to lengthen or shorten or to take up the varying distances at the top of the masts when they spring out of position through explosion. These springs do away with the necessity of lowering the aerial when the ship is being loaded, as they allow for the vibration of the masts caused by working the derricks, and they would, in fact, in some cases save the aerial from being blown away by shell fire.

Order THE WIRELESS AGE in Advance

Beginning with this issue, August, 1918,
No Returns of Unsold Copies Allowed
Except in Greater New York and Chicago

In order to work closely with the United States Government through the War Industries Board in the conservation of paper, we have made THE WIRELESS AGE non-returnable to news dealers, except as above stated, beginning with this issue, August 1918.

You can do your part by ordering your monthly copy in advance from your news dealer, handing him your yearly subscription, or mailing it direct to the WIRELESS PRESS, INC., 25 Elm Street, New York City.

If you experience any difficulty in securing your copy regularly from your news dealer please let us have his name and address and we will see that he receives enough copies to supply you.

To help yourself, your Government and your publisher we again suggest that you

ORDER IN ADVANCE

Wartime Wireless Instruction

A Practical Course for Radio Operators

ARTICLE XVI

By Elmer E. Bucher

Director of Instruction Marconi Institute

(*Copyright*, 1918, *Wireless Press, Inc.*)

EDITOR'S NOTE—This is the sixteenth installment of a condensed course in wireless telegraphy, especially prepared for training young men and women in the technical phases of radio in the shortest possible time. It is written particularly with the view of instructing prospective radio operators whose spirit of patriotism has inspired a desire to join signal branches of the United States reserve forces or the staff of a commercial wireless telegraph company, but who live at points far from wireless telegraph schools. The lessons to be published serially in this magazine are in fact a condensed version of the textbook, "Practical Wireless Telegraphy," and those students who have the opportunity and desire to go more fully into the subject will find the author's textbook a complete exposition of the wireless art in its most up-to-date phases. Where time will permit, its use in conjunction with this course is recommended.

The outstanding feature of the lessons will be the absence of cumbersome detail. Being intended to assist men to qualify for commercial positions in the shortest possible time consistent with a perfect understanding of the duties of operators, the course will contain only the essentials required to obtain a Government commercial first grade license certificate and knowledge of the practical operation of wireless telegraph apparatus.

To aid in an easy grasp of the lessons as they appear, numerous diagrams and drawings will illustrate the text, and, in so far as possible, the material pertaining to a particular diagram or illustration will be placed on the same page.

Because they will only contain the essential instructions for working modern wireless telegraph equipment, the lessons will be presented in such a way that the field telegraphist can use them in action as well as the student at home.

Beginning with the elements of electricity and magnetism, the course will continue through the construction and functioning of dynamos and motors, high voltage transformers into wireless telegraph equipment proper. Complete instruction will be given in the tuning of radio sets, adjustments of transmitting and receiving apparatus and elementary practical measurements.

This series began in the May, 1917, issue of THE WIRELESS AGE. Beginners should secure back copies, as the subject matter presented therein will aid them to grasp the explanations more readily. If possible, the series should be followed consecutively.

RECEIVER TUNING APPARATUS

DISTRIBUTED OR SELF CAPACITY OF TUNING COILS AND END TURNS

(1) Tuning coils possess **distributed** or **self-capacity;** that is, if an oscillatory E. M. F. flows in the coil, energy is stored between turns in the form of an **electrostatic field.** This causes the coil to act as an oscillation circuit. That is, it will have a well defined period of oscillation, and if it is employed as a tuning element in a radio frequency circuit, considerable energy will be absorbed—particularly if its natural frequency coincides with the incoming signal.

(2) In general, **self-capacity** is undesirable in tuning coils except in cases where the coil is used as the secondary tuning inductance and is to be operated over a limited range of wave lengths. In this case, its self-capacity may take the place of the usual shunt condenser.

(3) If a tuning inductance is designed to operate over a wide range of wave lengths and only a portion is used for a particular wave length there will be a number of **unused** turns attached to the circuit which play no part in the adjustments for resonance but absorb energy from the incoming signal.

(4) Modern tuning coils are equipped with end turn switches through which the windings are split into groups. Each group gives a definite range of wave length, and since the unused turns are not conductively connected to the used turns, losses which heretofore were experienced in such coils are partly prevented.

INDUCTANCES

(1) **Single** and **multiple layer tuning coils** are in use.

(2) The turns of multiple layered coils are **"banked"** to reduce their self-capacity.

(3) In the early types of radio frequency tuning coils the inductance was varied by sliding a ball or flexible strip over the bared portion of the coil. This arrangement obviously did not prove practical, because adjacent turns were soon short circuited, rendering the coil inoperative.

(4) In order that the requisite selectivity may be secured, tuning coils should be designed so that their inductance can be varied by at least **a turn at a time.** Through the use of two multi-point switches known as a **"tens"** and a **"units"** switch, the number of turns included in a given tuning circuit may be varied between one and maximum by single turns.

(5) Tuning inductances consisting of two fixed inductances in variable magnetic relation (often termed variometers) have been successively employed.

BUZZER EXCITATION SYSTEMS

To permit the receiving operator to pre-determine the most "sensitive" adjustment of the receiving detector, a **simple buzzer** may be employed to induce feeble currents in the receiving system. If some part of the buzzer circuit is inductively coupled to the antenna system, the aerial will be impulsed periodically and **set into oscillation** at whatever frequency it is adjusted. Various methods of coupling the buzzer to the tuning circuits are in use.

MICROPHONIC RELAYS

Incoming radio signals may be amplified by the use of **microphonic relays.** They have not been employed extensively although good results have been secured.

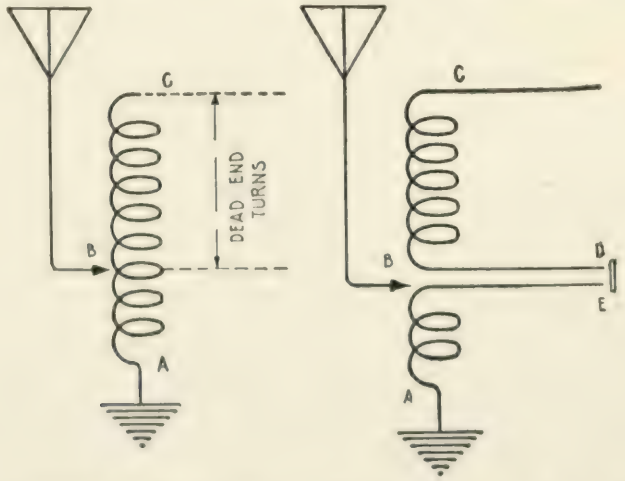


Figure 149—Diagram showing the "end turns" or "unused" turns of a radio frequency inductance. The coil A, C, is a radio frequency tuning inductance which is employed to tune the antenna circuit to various wave lengths. Suppose, for example, to establish resonance at the wave length of 600 meters only the turns between A and B are required. If the natural frequency of the coil A, C, is the equivalent of the wave length of 600 meters, part of the energy of the incoming oscillations will oscillate through the unused turns resulting in a decrease of the strength of signal. If the circuit is interrupted at points D, E, as shown in the right-hand part of the diagram, the "end turns" losses are greatly reduced.

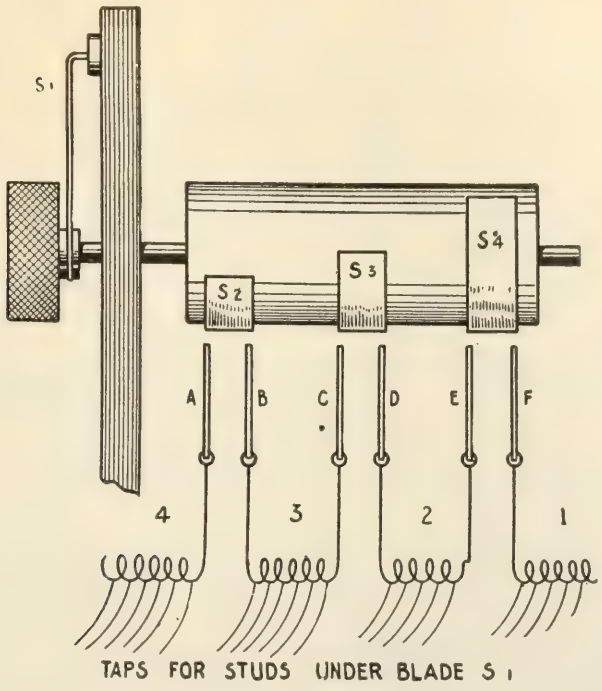


Figure 150

OBJECT OF THE DIAGRAM

Figure 150. To show the fundamental construction of the "end turn" switch employed in Marconi receiving tuners.

PRINCIPLE

It is desirable to cut off the unused turns of a radio frequency inductance in cases where the entire coil is not required for a given wave length.

DESCRIPTION OF THE DRAWING

The blade of the switch S-1, figure 150, makes contact with studs mounted in a circle to which are attached the taps 1, 2, 3, 4, leading to the tuning coil. A barrel switch operating in conjunction with the inductance changing switch carries brushes A, B; C, D; and E, F, which make contact with the copper segments S-4, S-3, S-2, successively.

OPERATION

Assume, for example, that higher inductance values than those furnished by the group 1, are required. The knob of the switch S-1 is turned counter-clockwise whereupon the copper segment S-4 makes contact with the brushes E, F, connecting the group 2 in the circuit. As the switch S-1 passes over the taps connected to group 2, the segment S-3 makes contact with brushes C, D, throwing group 3 in the circuit, and so on throughout the series.

SPECIAL REMARKS

(1) An end turn switch is provided for both the primary and the secondary coils.

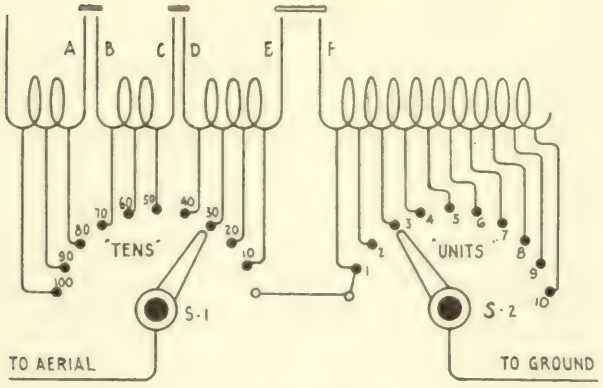


Figure 151

OBJECT OF THE DIAGRAM

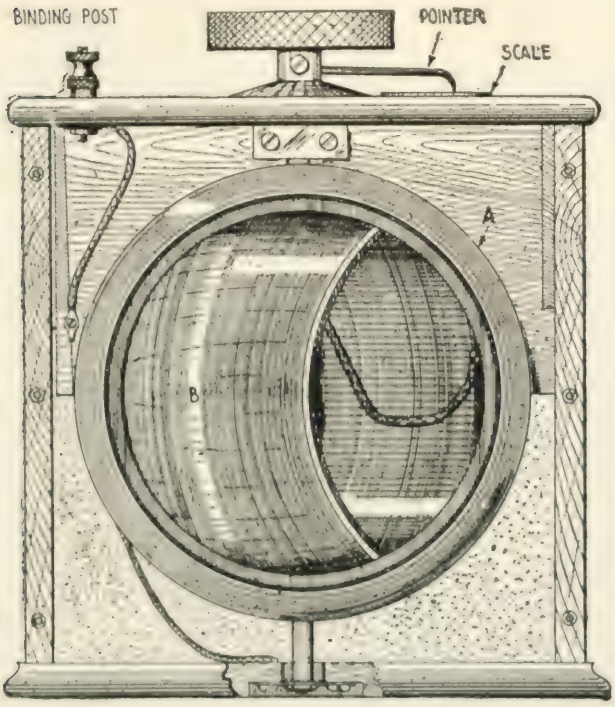
To show how the inductance of a radio frequency tuning coil can be adjusted by one turn at a time.

DESCRIPTION OF THE DRAWING

The contact points of the switch S-2 are connected to the first ten single turns in the coil. The studs of the switch S-1 are connected to each tenth turn progressively. The coil is interrupted by an end turn switch at the points A, B; C, D; and E, F.

OPERATION

Assume, for example, that the operator desires to connect 37 turns in the circuit; switch S-1 is set on the contact marked 30, and switch S-2 on the contact marked 7, the circuit between the single turn switch and the additional groups being closed at E, F, by the end turn switch.



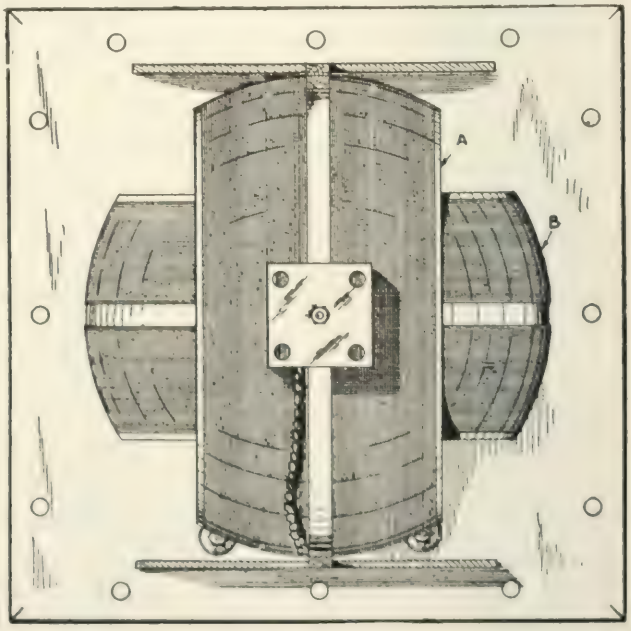


Figure 152, *Figure* 153—*Showing the construction of a variometer adaptable to radio frequency tuning in receivers. Mounted inside the stationary coil A is the ball winding B, which rotates on a shaft. A knob and a pointer is attached to the shaft passing over a suitable scale cut in the cover. Coils A and B are connected in series. The inner coil moves through an arc of* 180°. *In one concentric position the magnetic fields of the two coils oppose, and the inductance of the variometer is practically zero. In the opposite concentric position, the inductance is maximum. At intermediate points the inductance varies as the angle of the coils.*

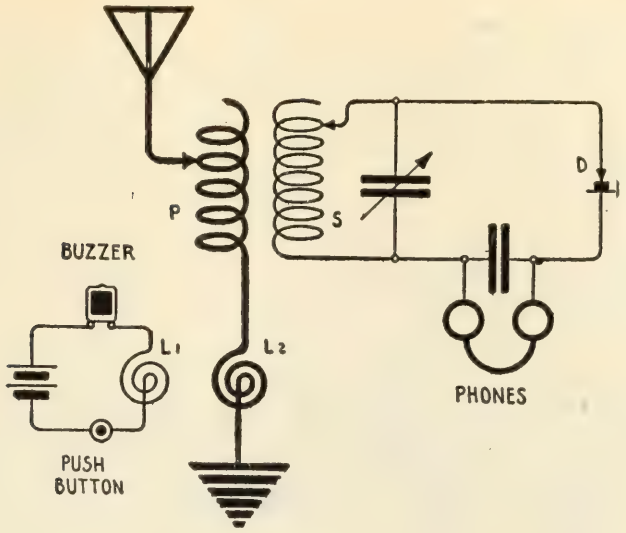


Figure 154—Showing how a buzzer excitation system is coupled to a receiving circuit. The object of this apparatus is to permit the receiving operator to adjust the receiving detector to its best operating condition in advance of the reception of signals from a given transmitting station. The coil L-1, which is part of the complete buzzer circuit, is placed in inductive relation to the earth lead of the antenna circuit at L-2. When the buzzer is in operation, an E. M. F. is impressed across the coil L-2 setting the antenna circuit into oscillation at whatever frequency it happens to be adjusted. Oscillations of similar frequency are induced in the secondary circuit and are rectified by the detector D, response being obtained in the head telephone. The operator tries various points of contact on the crystal until maximum response is secured. The buzzer system may be conductively as well as inductively coupled to the antenna circuit.

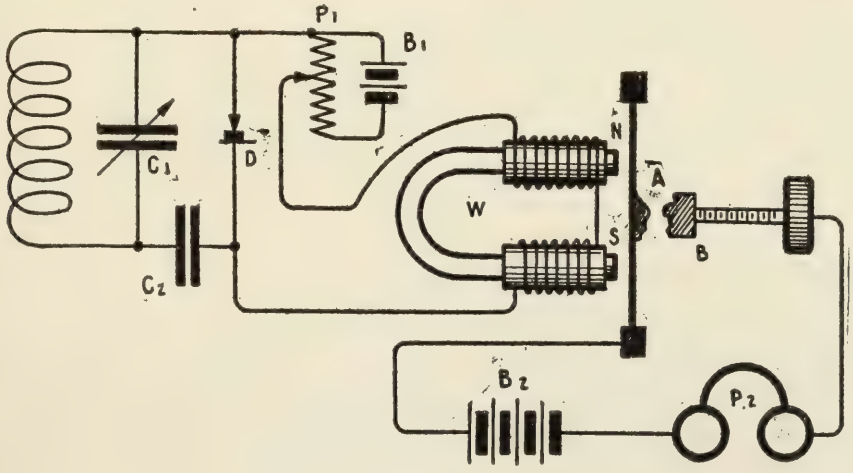


Figure 155

OBJECT OF THE DIAGRAM

To disclose the fundamental principle of the microphonic relay.

PRINCIPLE

By attaching a microphone to the diaphragm of a receiving telephone, the vibrations of the diaphragm may be magnified in another telephone receiver through the use of a local battery.

DESCRIPTION OF THE APPARATUS

The secondary circuit of the receiving tuner is represented by the usual tuning elements. The circuit of the battery B-1, potentiometer P-1, and the crystal D, being completed through the magnet windings W. The poles of the magnet N, S, act upon the telephone diaphragm P which carries the carbon button A. The carbon button B is mounted so that its pressure on A can be closely adjusted. The complete microphone circuit includes the carbon buttons A, B, the telephone P-2, and the battery B-2.

OPERATION

During the reception of signals, the crystal detector is adjusted to its best operating condition by means of the potentiometer P-1. The operator then adjusts the pressure on the microphonic contacts A, B, until the loudest response in the head telephone is secured.

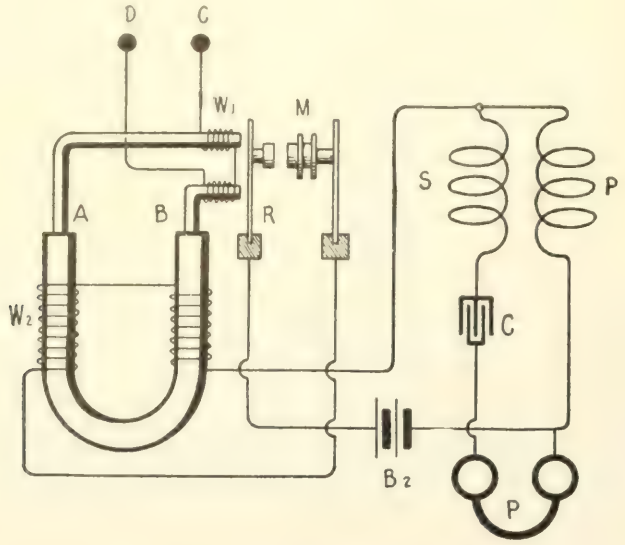


Figure 156—Showing the construction of the supersensitive Brown amplification relay. M is a microphone chamber field with carbon granules, the pressure of which can be carefully regulated by means of an adjusting screw. The vibrating tongue R is actuated by the flux of the poles A, B. The current to be amplified enters the winding W-1 at the terminals C, D. The vibrations of the diaphragm R vary the resistance of the microphone M. The resulting fluctuations of current in the local circuit (fed by the battery B-2) flow through coil P and also through the winding W-2 which acts to increase the amplitude of the vibrations of R. The potential of the resulting fluctuating current is increased through the transformer P, S, the circuit from S to the telephone including the condenser C. Condenser C has about 2 microfarads capacity and the battery B-2 has an E. M. F. of approximately six volts.

ATMOSPHERIC ELECTRICITY (STATIC)

A serious interference encountered in wireless telegraph stations throughout the world is that due to vagrant electrical waves which will set a receiving antenna into oscillation at the frequency to which it is adjusted.

Widely varying theories exist as to the origin of these electrical waves, but a considerable amount of this interference is set up by nearby or far-distant electrical storms.

These interfering waves are sometimes termed **atmospheric electricity.** In foreign countries they have been given the name of **"atmospherics"** or **"strays."** The popular term in the United States is the word, **"static."**

The currents induced in the receiver by "strays" causes a crackling irregular sound of greater or lesser intensity in the receiving telephone which may interfere to a marked extent with the reception of radio telegraphic signals. Three kinds of "strays" are recognized in practice:

(1) Those known as "grinders," consisting of a more or less prolonged rattling or grinding noise;

(2) Strays consisting of sharp isolated knocks, termed "clicks";

(3) Strays consisting of a buzzing or frying noise, called "hums" or "sizzle."

The latter are often observed as an accompaniment to a squall or a snow storm.

It may be said that the origin of these atmospheric discharges is not fully understood, and so far they have presented a problem which has not been completely solved.

To reduce the interference of "strays," the transmitting apparatus is designed to produce a spark note of high pitch having a more or less musical tone. The telegraphic characters can then be readily distinguished at the receiving station due to the difference in pitches of the interfering "strays" and that of the spark at the transmitting station.

Modern transmitters energized by 500 cycle alternating current produce a musical spark note which permits communication to be carried on through "strays" which would not be possible with a spark gap giving a note of non-uniform pitch.

When the receiving apparatus is connected to very large aerials severe static interference is obtained throughout the day and night, and in order to carry on communication through this interference, a transmitter of very great power is required that will permit the desired signals to be heard over the interfering sounds.

The effects of atmospheric electricity are overcome

(1) by the employment of large powers at the transmitting station (much in excess of that required in the absence of atmospheric electricity);

(2) by reduction of coupling at the receiving transformer.

A special receiver has been devised by Marconi to eliminate the crashing sounds of atmospheric discharges in the telephone.

The apparatus carrying out this principle is known as the balanced crystal receiver, in which two oscillation detectors are connected in opposition. The effect of this mode of connection is to limit the maximum sound created in the head telephone by atmospheric discharges. The operator's ears are thus protected from the heavy crashing sounds which ordinarily would be obtained from the head telephones.

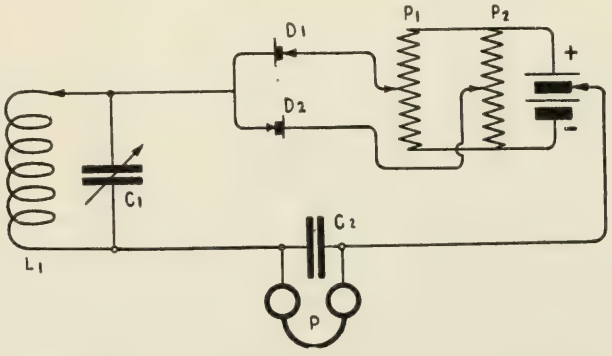


Figure 157

OBJECT OF THE DIAGRAM

To show the circuits of the Marconi balanced crystal receiver.

DESCRIPTION OF THE DRAWING

In figure 157 two carborundum crystals, D-1 and D-2, are connected in the receiver circuit in such a way as to oppose each other's effects. Both crystals should have nearly identical operating characteristics, but they are not worked at the same point on the characteristic curve; that is, they are not adjusted to the same degree of sensitiveness.

OPERATION

If the crystals D-1 and D-2 are adjusted to be equally sensitive to the incoming oscillations (by their potentiometers) no sound will be produced in the head telephone P.

If, however, crystal D-1 is adjusted to a "sensitive" state and crystal D-2 to a slightly less sensitive state, an incoming signal of a small E. M. F. will produce sufficient change of current in the head telephone P to create a sound. On the other hand, if a severe discharge of atmospheric electricity strikes the aerial, the local currents of crystals D-1 and D-2 will reach almost identical maximum values (approach the saturation point) and will almost completely neutralize. In other words, strong signals or strong discharges of atmospheric electricity will cause greater opposition between the crystals than weak signals. Hence, the sound produced by the telephone is limited, and the operator's ears are accordingly protected leaving them in a "sensitive" condition to receive the desired signal.

(C) Int. Film Svce.

A portable wireless station established for communication under a white canvas shelter appears, in this instance, to point the finger of scorn at what we have thus far considered necessary in the way of camouflage. The station is Bulgarian, according to the correspondent who secured the photograph and is considered of high efficiency by that nation of disturbers of Europe. Apparently the equipment consists of sending and receiving radio instruments with the usual telephone accessory. The presence of the reel device on the table leads one to assume that it is either a tape receiver or a Wheatstone transmitter. Why automatic transmission of military messages should be thought advisable is not clear in view of the constant cry for haste in war intelligence. Assuming the Wheatstone eliminated by this handicap, there remains consideration of the device as a tape recorder, which in turn is cause for speculation as to whether the Bulgars are still back in the coherer stage of radio or are springing something entirely new

Signal Officers' Training Course*

A Wartime Instruction Series for Citizen Soldiers Preparing for U. S. Army Service

By Major J. Andrew White
Chief Signal Officer, American Guard

FIFTEENTH ARTICLE

(*Copyright, 1918, Wireless Press, Inc.*)

Field Lines

General Provisions

FROM instruction with the buzzer the work will be carried on in actually laying field lines on the drill ground or along such roads as are available. The units for this work will be the section, platoon, and company. Whether operating alone or in combined training each section lays, operates, and maintains its own line. Two kinds of wire are provided for this work: The 11-strand field wire, which will be used when possible, and the 3-strand buzzer wire.

The Wire Cart

The means provided for laying field lines is a wire cart, with drums and an automatic gear for picking up the wire when driving back over the line. This is supplemented by carriers for buzzer wire to be used by men on foot or mounted.

Immediately after each drill, maneuver, or other formation, the wire cart will be thoroughly inspected by the chief of section. Notes will be made of necessary repairs, and turned in by him to the company commander. An inspection will be made prior to each formation by the chief of section, to see that all the bearings of the cart are clean and oiled, except the clutch, which will be bright and free from oil. He will see that the axles are greased and the harness in repair; that oil cans are full, and that there is no sediment in the holes to prevent the oil from reaching the bearings.

To Clean the Wire Cart

Always after the cart has been used, after each formation, before the cart is parked, the drivers and cart operators will thoroughly clean the chains, friction clutch, and sprocket wheels with a stiff brush and rough cloth, removing all dust, dirt, and hard oil. After cleaning, these parts will be gone over with a well-oiled cloth to prevent rust.

Once each week, or when directed by the company commander, the section will be assembled, and, under the supervision of the chief of section,

* The articles in this series are abstracted from the complete volume, "Military Signal Corps Manual," by the same author.

the cart given a thorough washing and cleaning throughout. All dirt and dust will be removed from the woodwork with a broom or stiff brush, and dust and oil from the metal parts with a cloth. Hose will then be used to wash the cart, if available; otherwise pails and sponges will be used. The metal parts will be wiped dry before oiling.

Occasionally the friction clutch will be taken apart under the supervision of the chief of section and cleaned with gasoline. A light oil will be sparingly used before assembling to prevent rust.

In the field paulins will be placed over the carts after use, and not removed until the cart is again used. These paulins will be folded and placed on the chest when the cart is in action.

MANIPULATION OF THE WIRE CART

The manipulation of the machinery of the cart for handling wire will be a part of the duty of the cart driver, unless an operator be placed on the

Rear view of the wire cart, care and manipulation of which is an important feature of Signal Corps instruction

cart, in which case the latter will do this. He will stop the cart at command or signal from the chief of section.

The reel will always be stopped before a march to the rear is taken up.

In spooling up wire the reel should be stopped when the loop gets too short and the clutch should be thrown in before the loop gets too long.

LAYING THE LINES

Slack will be pulled back and the wire tied in every 500 or 600 yards, or when the section chief directs. The line will always be tied at turns, in such manner as to prevent the wire from crossing the roads. Under no circumstances will the wire be so tied as to subtend the arc formed by any turn in the road. Should a number of turns come together, the cart will be halted until the work is satisfactorily performed. Ties will be made by two round turns and a half hitch, around bushes, trees, or anything fixed in the ground, and as close to the ground as possible.

At points where the line crosses roads or at crossroads the line will be raised overhead or buried, unless the road is little traveled, when it may be tied on each side with plenty of slack. When there is nothing to tie to, stones will be placed on the wire on either side of the road.

Generally the wire will be laid to one side of the roadbed to avoid

unnecessary damage to the wire from wheels, etc., but in unfenced country, where mounted men and stock may approach the road from the adjacent fields, it will frequently be advisable to lay it in the road, so that it will be flat and also be more easily seen.

Plenty of slack wire always will be taken, so that it will drop off the feet of animals passing over it, without breaking the wire or throwing the animal.

In crossing railroads or trolley lines, the wire is cut and the ends run under the rails. To prevent delay, a man of the section will be dropped off at such crossing and connect the wire, then overtake the section at an increased gait.

To repair a break the ends will be first scraped, the scraped ends tied in

Signal Corps men laying the lines in accordance with the regulations prescribed in the accompanying article

a square knot, the loose ends twisted around the line wire, and all carefully insulated with tape. The knots should be pulled tight and made as small as possible, so that in reeling up the knots will not jerk the pike and glove from the hand.

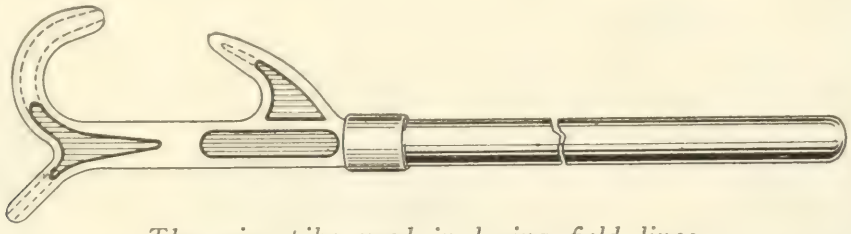
Lines which have been hastily laid will be patrolled at once, the linemen proceeding from each end until they meet, reporting from there by wire to their sections for instructions. In thus patrolling the lines it will be with a view to placing the wire flat on the ground, should it have become taut after the section passed, and otherwise arranging it to lessen the likelihood of breaks. Should a line cross a macadamized road, heavily traveled by artillery and cavalry, with no means to place it overhead, a lineman will be left at the point to repair any possible break. Should travel over the road practically cease, he will ask for instructions by wire.

Frequent patrols will be made over lines which pass over fields of grain, weeds, or underbrush in unfenced country, and can neither be placed flat on the ground nor overhead. Breaks are more apt to occur with lines thus laid.

On all occasions in handling wire, such as reeling it on to the reels in filling them or reeling it off for repairs, the section chief will have leaks in insulation repaired and all connections looked over. This aids materially in the working of the lines when the wire is laid.

Maneuvers of the Battalions

Wire will not be picked up at a faster gait than a trot. Should a more rapid gait become necessary to escape capture, the wire will be cut and abandoned. The real object is to lay wire and not to pick it up. Should wire have to be abandoned, the cart will refill its reel at the earliest possible moment from the reserve. Wire will only be temporarily abandoned at maneuvers. The section will return for it when the maneuver is completed. Under no circumstances will wire be reeled up on the reels or spools until any breaks in the metalic continuity of the wire have been repaired.



The wire pike used in laying field lines

In passing through villages, the wire will be placed overhead on telegraph and telephone poles. The climbers carried with the cart will be used for this purpose. A man will be dropped for this work; when completed, he overtakes the section. Men left behind in laying the wire, for any duty, will follow the line in overtaking the section, looking for breaks.

The gait to be taken in laying lines will depend on the kind of troops the section is following and the speed made by them. In all cases the line will keep in touch with the element it is to transmit information for. When the last station is cut in, horses may be unhitched if the troops seem likely to remain in place any length of time.

On the care with which lines are laid will depend in no small degree their efficiency. Carelessly laid lines will need much attention to repair breaks, and will cause many delays in messages, and no end of annoyance to other troops.

Speed will always be sacrificed to carefulness in this work. Wire fences, telephone and telegraph lines may sometimes be used to advantage.

Stations and Call Letters

Each section will be assigned call letters for four stations, which in general should not exceed four. The first section will be given the letters A, B, C, and D; the second section the letters F, G, H, and K; the third section M, N, Q, and R; the fourth section, S, U, W, and X. The stations are assigned to call letters in order of establishment, no location, beginning with the first letters. The call of headquarters is KO, which will be its call whenever it may be on the line, suspending for the time being the letter of the station where it may be. This applies to the first station established as well as to the later ones.

Branch lines electrically connected with the main line have offices given calls as if on the main line.

An office on a branch line not connected with the main line will be assigned the call letters of the station where the branch goes out, adding J to it.

As soon as a station is established the operator will call up the initial station and report. The opening of all stations, including the initial station, will be reported to the officer or non-commissioned officer in charge of the line, and by the latter to the company commander and to the commanding officer for whose use the line was established.

Each operator will have a personal sign, as Smith "SM," Johnson "JO," etc.

To open station with buzzer the operator will attach the buzzer connector to the line wire and ground rod. Care will be taken that the teeth of the connector have penetrated the insulation of the line wire. Damp ground will

A field wire station open and in operation under actual service conditions

be sought for the ground rod; if not available the ground will be dampened around it with water from the canteen.

The operators will not leave their buzzers unless properly relieved by higher authority.

At night, when lanterns are necessary at a station, the light must be so placed as to conceal it from hostile observation.

When it becomes necessary to move a station some distance from the line and it is not practicable to use field wire for extending the line, the buzzer carried by the lineman may be used.

The buzzer carried by the lineman may be used for opening stations on branch lines.

Stations will be conducted in a military manner. Silence will be preserved, except conversation relative to business. The lines will not be used for conversational purposes between operators.

Buzzers will be kept dry. In case of wet weather the shelter tents of messenger and operator will be made into an office.

No unauthorized person will be allowed around stations.

Maintaining the Lines

Each lineman will be equipped with a carrier with one-fourth mile buzzer wire and a buzzer for testing the line. This will enable linemen to determine in what part of the line a break may be. Intermediate stations will assist in this, and when the section in which the break exists has been located the messenger or any available man will be sent to find and repair it if no lineman is at hand. In following the line to locate breaks the lineman will take up the gallop, following the line with his eye where it is raised from the ground, and with the pike where it is on the ground. He picks it up with the hook. In order to prevent a knot or splice from being caught in the hook and jerking the pole from his hand he raises the pike in a horizontal position, slips the wire out of the hook and on to the handle, and allows the wire to run on it near the hook, the shoulder of the hook keeping it from slipping off. By lowering the pike and turning it around in the hand the wire slips quickly to the ground.

Signal Corps News

The War Department authorizes the following statement from the Land Division of the Signal Corps:

Technical Men Needed

The demand for specialists in the American Army is increasing daily. Mechanics and technicians of every kind, including radio and buzzer operators, are needed by the Land Division of the Signal Corps.

Through the assistance of the Federal Board for Vocational Training, an opportunity is extended to men in the draft to perfect themselves in radio and buzzer work without expense, enabling them to select this branch of the service in the Signal Corps when they are called.

The Signal Corps has charge of all signaling and communication, including radio, telegraph, telephone, and cable service for the mobile Army, both at the immediate front and behind the lines. It is important and interesting work, since without this branch of the service the Army's "ears" would be stopped and in many instances its "eyes" would be valueless. Men who are expert telegraph and radio operators in civil life have an opportunity here to continue their specialty.

In nearly every large city the Federal Board, through local school authorities, has established schools of radio communication where all men of draft age who have not yet been called may receive a preliminary course in the operation of radio and buzzer instruments. There are now about 600 of these schools, where continuous instruction is given, usually during afternoons and evenings. It takes practically 200 hours for a student of average ability to attain a speed of 20 words per minute, sending and receiving.

If a student enrolled in one of these schools is ordered to report for military service by his local draft board before he has completed his course, he will be furnished with a proficiency card, stating the number of words he can send and receive. Upon the presentation of this card to the personnel officer at the mobilization camp to which he is sent he will be assigned to the Signal Corps.

If, after attaining a proficiency of 10 or more words per minute, a student decides that he desires to enter the service immediately, he may apply through the local school authorities to the Signal Corps for papers authorizing his individual induction into the service and his assignment to a radio school for advanced training.

The Signal Corps is particularly in need of highly trained technical personnel. Electrical engineers and men with a good fundamental training in engineering or physics will find excellent opportunities for service of a character which will permit them to make full use of their training and experience. Men of satisfactory qualifications are given three months' training in special Signal Corps schools operated under the supervision of the Land Division of the Signal Corps, and are given every opportunity to take examinations leading to promotion.

Men who have had experience as electrical repair men, wiremen, and mechanics are also desired for assignment to special schools and later to field organizations. Instruction of a high grade is given, and opportunity for promotion is excellent.

* * *

The following statement is authorized by the War Department:

Fitting Men to Army Units

Latest figures show that nearly 240,000 transfers of men from one unit to another have taken place in Army camps in this country as a result of occupational qualifications ascertained through the committee on classification of personnel of The Adjutant General's office.

The speeding up of preparations for over-seas service during the past few weeks has meant a great increase in the work of the committee. About 40,000 transfers have taken place each week recently.

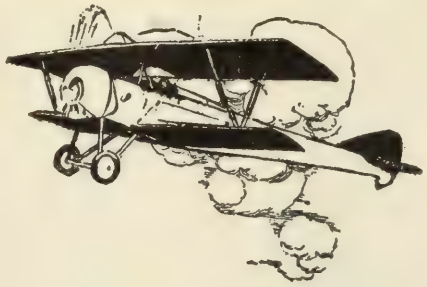
Through the medium of the committee an organization has been built up in all Army camps by which enlisted men and commissioned officers are classified according to occupational qualifications. In some of the camps, where as many as 2,500 men are received daily, a force of 200 trained interviewers is employed to ascertain full information regarding the men's occupations, education, experience, and special qualifications.

The central personnel bureau at Washington receives reports soon after the arrival at camp of each draft increment, showing the number of skilled and semi-skilled men in different occupations. The Signal Corps, Ordnance, Quartermaster, and other corps are constantly making requests for skilled men needed by their special troops. By means of the occupational classification the transfers are promptly made.

A general order which has just been issued requires that every enlisted man leaving this country shall have made out an occupational card. This enables officers on the other side to place men where they can be most useful.

How to Become an Aviator

The Thirteenth Article of a Series for Wireless Men in the Service of the United States Government Giving the Elements of Airplane Design, Power, Equipment and Military Tactics



By J. Andrew White
and Henry Woodhouse

(*Copyright, 1918, Wireless Press, Inc.*)

BEGINNING consideration of actual flight, a preliminary survey of the aviator's equipment and aids is advisable. These consist of his clothing and accessories and the instruments which aid navigation of the air. Many arguments are advanced for the method of instruction by which the pilot acquires a sense of "feel" without dependence upon mechanical devices, but while this instinctive knowledge is essential, intelligent use of the instruments undoubtedly increases the aviator's efficiency.

Clothing—A warm coat is a necessity, for even in summer it is cold at high altitudes. In winter a fur lining is advisable; in ordinarily moderate weather the service uniform covered by a leather coat is sufficient. Pockets without flaps, closing by an elastic band, should be of generous size so that papers may be easily put away with one hand. Warm socks are essential and soft boots or puttees without straps should be worn with the riding breeches. Fleece-lined soft leather gauntlets, allowing easy freedom of fingers and wrists, are the proper protection for the hands. A padded helmet is a necessity. The aim in selecting clothing is to provide flexibility of movement and protection from the cold with the minimum of straps and strings to catch on the obstructions within the cockpit. Above all, clothing must be comfortable.

Goggles—As a protection from the wind, even though the airplane be provided with a wind shield, goggles should be used to take the strain off the eyes. Glass lenses should not be used; they should be made of colorless celluloid with a green shade at the top and bound by a stiff rubber rim shaped to conform to the face. A small piece of chamois should be carried to wipe off the flying oil.

Watch—An accurate timepiece with a wrist strap is essential to the military aviator.

Safety Belt—Under no circumstances should the aviator venture aloft without his safety belt adjusted. This device consists of a wide web of heavy webbing with a quick detachable locking device. The belt should be securely adjusted with the stress coming at the thighs.

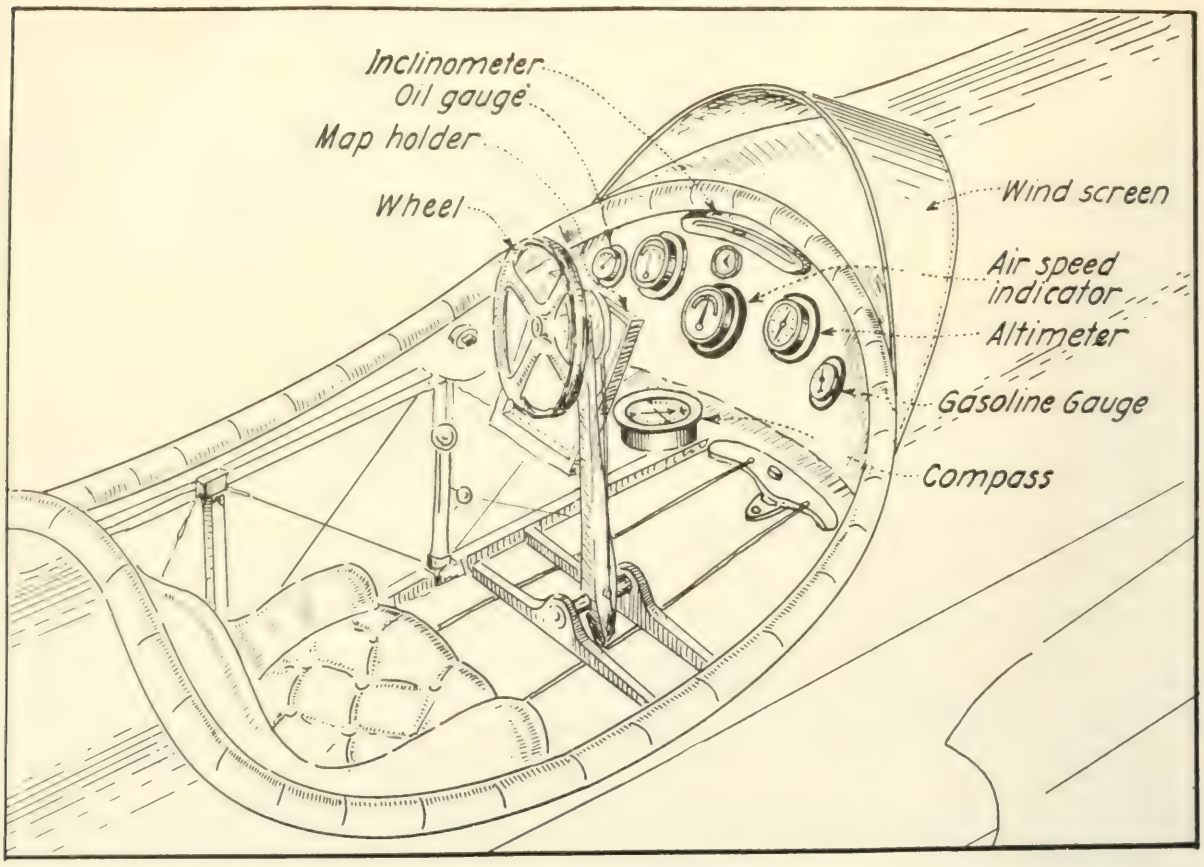


Figure 71—General view of a typical airplane cockpit

AIRPLANE INSTRUMENTS

SCOPE AND USEFULNESS

As with any class of travel, reaching the destination by air flight requires knowledge of position. The aviator obviously must also know the direction of his machine toward the horizontal. In or above the clouds, out of sight of earth, knowledge of these essentials must be gained through instruments. The devices required for air navigation must be compact and rugged, light, reliable and accurate.

GAUGES

An oil gauge definitely indicates the amount of oil in the crankcase, an oil-pressure gauge accurately indicating undisturbed flow and the pressure in the oil system. The gasoline gauge registers the quantity of gasoline available in the tanks, preferably by mechanical means.

LUMINOUS DIALS

Paints and compounds which illuminate pointers and figures on instrument dials are now in general use, electric lighting having been largely done away with because of the glare and the vibration to which lights are subjected. Zinc sulphide combined with radium are the main constituents of the most reliable luminous paints.

COCKPIT ARRANGEMENT

Wherever practicable, well upholstered seats are provided for aviators and in many cases comfort is further promoted by passing heated exhaust pipes through the cockpit. Figure 71 shows a typical arrangement of the pilot's seat and dash with air navigation instruments in position of easy visibility.

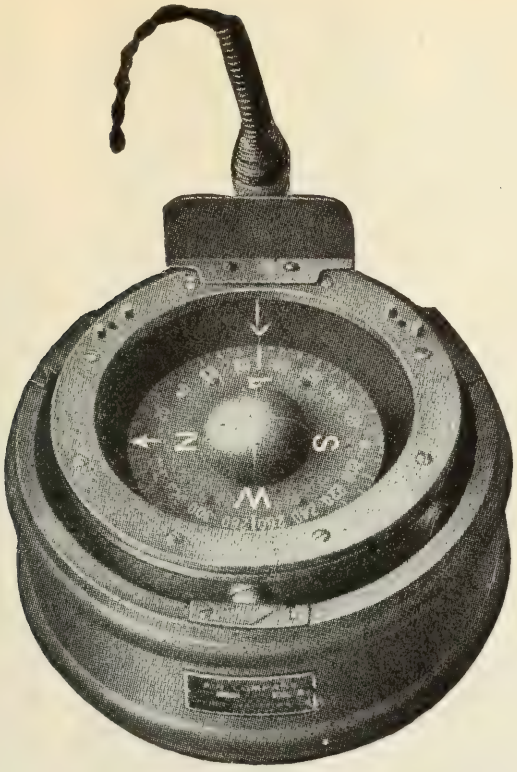


Figure 72—A military airplane compass

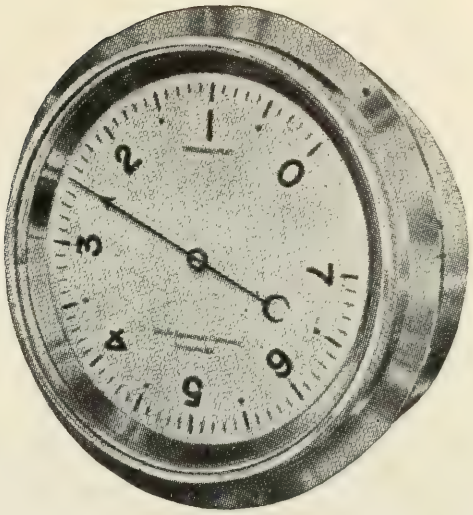


Figure 73—The barometer or altimeter

COMPASS

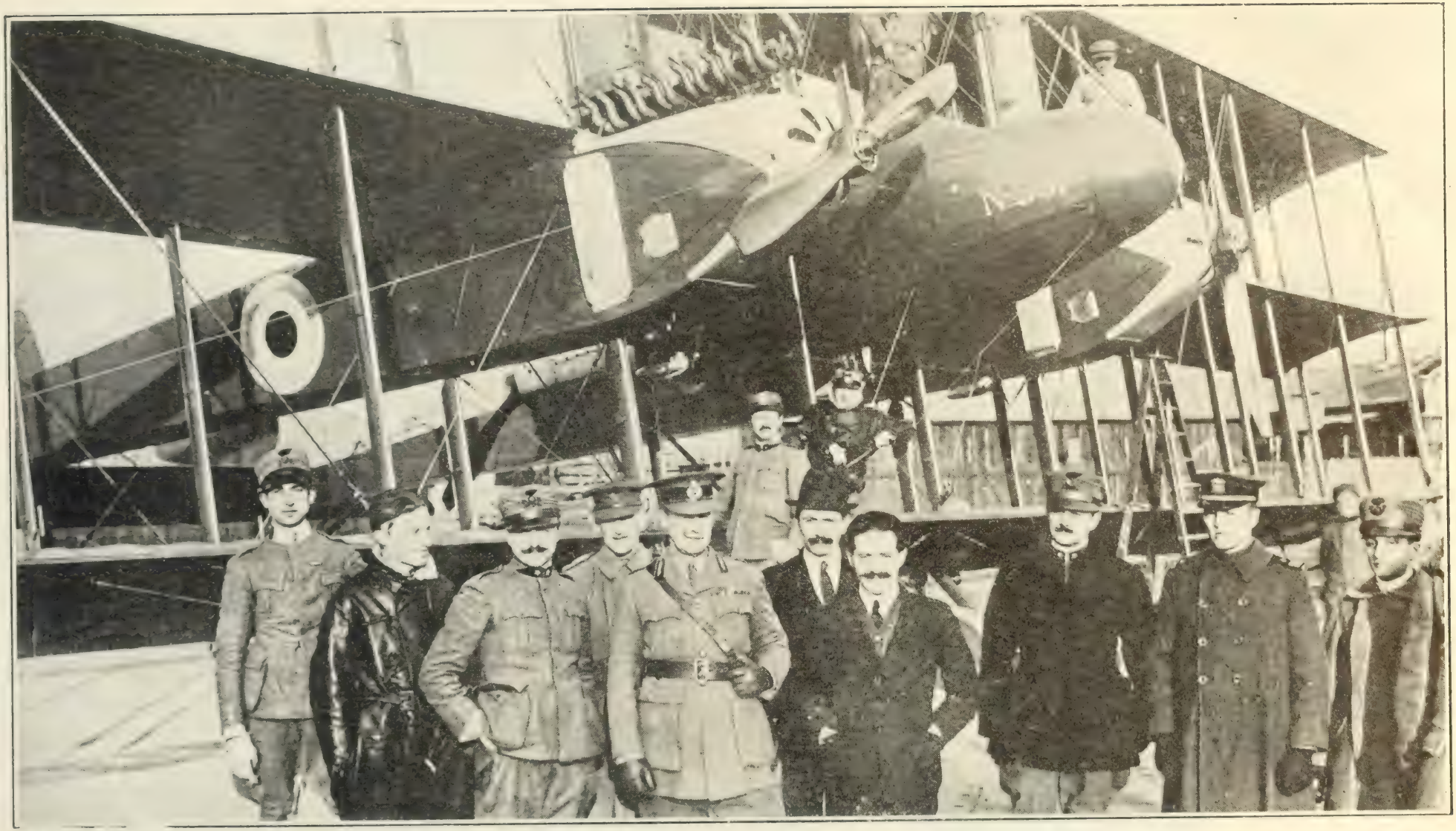
Air navigation, as well as sea, requires the aid of the compass, a device which contains a magnetic needle constantly pointing to the magnetic north. In the aviation compass illustrated in figure 72 a compensating attachment counteracts stray magnetic influences. The card, or graduated scale, floats in a mixture of alcohol contained in the inner bowl, the latter being bedded in horsehair, which absorbs vibration. The alcohol varies in proportion to water from 45 per cent to almost pure alcohol, the high percentage being maintained to prevent freezing at high altitudes.

BAROMETER OR ALTIMETER

To indicate the height of the airplane above the earth is the function of the instrument illustrated in figure 73. Essentially, it comprises a vacuum chamber which is acted upon by the varying density of the air. The dial is adjusted to zero on the ground. Location of the instrument on the airplane is of great importance by reason of the possibility of influence by velocity pressure.

TACHOMETER

This instrument, not illustrated, is in all essentials similar to the speedometer used for automobiles, except that it registers the number of revolutions of the motor. Its importance may be estimated by considering that the power delivered by the engine is directly related to its speed of revolution and that the speed of its turning may be used to compute the airplane's speed relative to the air. Tachometers are either magnetic or electric, the former type consisting of a magnet rotated by a flexible shaft coupled to the engine, and the latter comprising a generator, engine driven, electrically connected to an ammeter. With both type the indications are made by a needle and graduated arc on the dash.



(C) Press Ill. Svce.

The amazing development of aircraft is revealed in this photograph of the new Caproni triplane, features of which are the twin 12-cylinder motors and tractor screws with the addition of a pusher propeller behind the nacelle. The wireless generators are located on the struts just underneath the engine beds. In the center of the group are the Caproni brothers, builders of the leviathan of the air

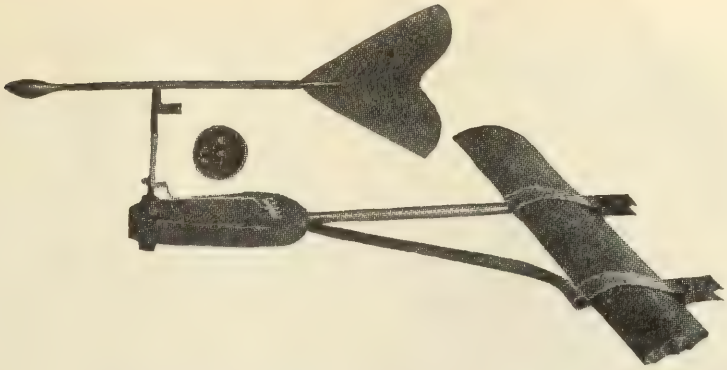


Figure 74—Angle of incidence indicator

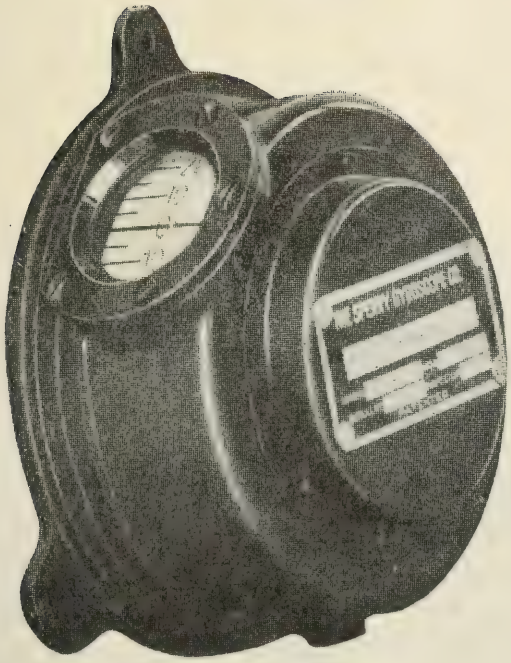


Figure 75—An inclinometer

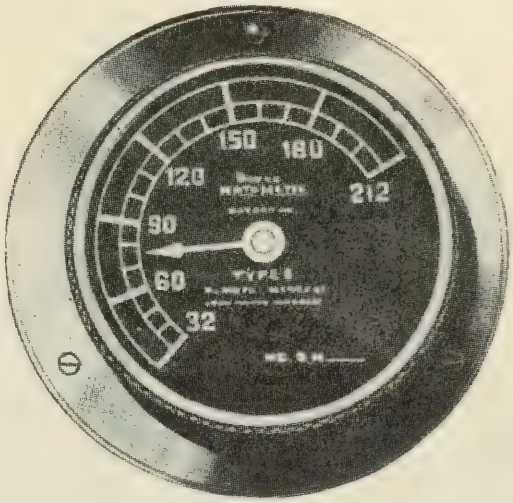


Figure 76—Engine temperature meter

ANGLE OF INCIDENCE INDICATOR

This device, illustrated in figure 74, is mounted on a forward strut clear of the influence of the propeller and the body. The vane, which remains level when the airplane is in motion, has a pointer and indicator graduated in degrees and visible to the aviator. The instrument shows the angle between the chord of the wings and the flight path. By means of a dry battery and electrical connections the round light bank shown is attached. When the flight is level no light shows. A white lamp signals when a dive is made at too steep an angle. A red light warns of an angle close to the stalling point. A green light indicates the best climbing angle.

INCLINOMETER

Two types of inclinometers are illustrated. The spirit-level type shown mounted on the dash in figure 71, is inaccurate in the presence of accelerations and has generally been superceded by the instrument illustrated in figure 75. This device registers the angle of the airplane with the horizontal, the scale being on a weighted wheel which is damped by floating in liquid, which insures sensitiveness and increases accuracy. The scale tips forward or backward with the angle of the airplane, the dial being mounted on the instrument board in the cockpit.

RADIATOR TEMPERATURE INDICATOR

The value of this device, illustrated in figure 76, is obvious when it is considered the great altitudes attained by airplanes and the necessity of knowing whether the motor is getting cold. Equally important is knowledge of imminent overheating. The instrument is, therefore designed to register from freezing to boiling.

Figure 78—Air speed meter

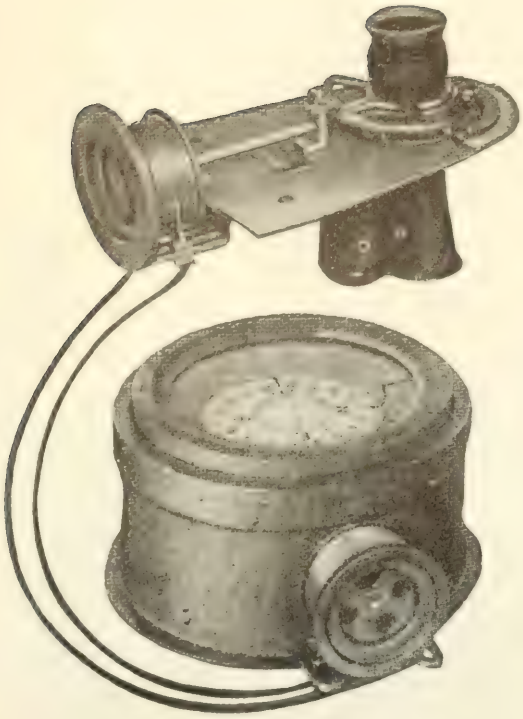


Figure 77—The drift meter

Figure 79—Banking indicator

DRIFT METER

The purpose of this instrument, shown in figure 77, is to enable the aviator to remain on a given course to his destination, irrespective of drift occasioned by side winds. The device comprises a telescope pointing vertically to the earth with hairs crossing the field of vision. A scale and pointer indicates the angle of drift in degrees and the compass lubber line moves automatically to correct for any existing drift. The instrument is widely used for cross-country flight.

AIR SPEED METER

This mechanism shows the airplane's rate of speed relative to the air. It serves to correct for the aviator any erroneous impressions which may be gained by his speed in relation to the ground, since that speed varies according to whether his airplane is flying with or into the wind. It is also useful to indicate excessive gliding speed, straightening out from which may stress the machine to dangerous limits. The principle of its operation is pressure of wind on a liquid contained in a tube, a lead from one end of which is open to the wind. This device is also known by the names, manometer and Pitot tube.

BANKING INDICATOR

The proper lateral attitude of flight is shown on this instrument by the airplane outline on a fixed dial, below which is a bar rotating from the center and controlled by a pendulum inside the case. When the indicator bar and the wing outline are parallel, as in the illustration, figure 79, the machine has the proper amount of bank. The pendulum swings outward in proportion to the radius and speed of the turn, and when the pilot has not properly banked his airplane the indicator bar will be out of parallel with the wing outline on the dial. The pilot then merely operates his controls in the indicated direction until the parallel is again registered. The instrument is of special value to the aviator at night or in a cloud or fog when human sensibilities are not dependable.

Figure 80—An airplane headed into the wind, the position for the start

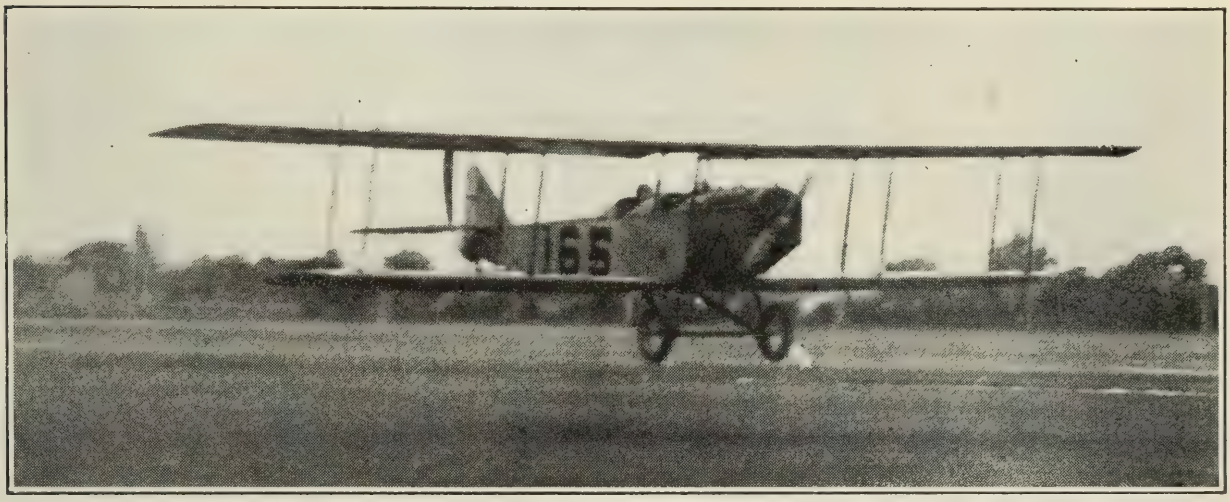


Figure 81—Taxying at the start with wheels on the ground and tail raised

FIRST FLIGHTS

POSITION FOR THE START

The airplane should be turned directly against the wind, as this position aids the initial rise from the ground and makes it easier to maintain balance, a difficult matter in a cross wind.

LEAVING THE GROUND

The engine should be developing full power for the required thrust before the signal is given for the mechanicians to let go. As the airplane starts forward along the ground, the tail stabilizer is depressed by moving its control forward. This causes the tail to rise from the ground and places the lifting surface more horizontal, offering less resistance as rolling speed is acquired. Figure 81 illustrates this position. When the machine is taxying at a velocity equal or greater than the airplane's low flying speed, the tail control is pulled back gently and held. The tail end of the machine then drops and the angle of incidence of the wings is increased, causing the airplane to rise.

A minimum distance of 100 yards (covered in 5 to 10 seconds, according to the wind) is allowed between the starting point and the rise from the ground.

CLIMBING

The tail control is pulled back slightly and held fixed in the new position, further increasing the lifting surface angle of incidence. The motor is then accelerated to its proper climbing speed.

The airplane should be pointed into the wind for the first 200 feet of altitude and the student flier should rise at least 100 feet. A landing made from a lesser height is valueless for instruction purposes.

Aviation News

Navy Dept., Office of Naval Operations,
Washington, D. C.

Navy Flying Uniform

The following service flying uniform for officers detailed for aviation duty and officers of the Naval Reserve Flying Corps is prescribed. This uniform will also be worn by student officers with the exception as enumerated in paragraph under student officers. This cancels Changes in Uniform Regulations, U. S. Navy, 1913, Nos. 11, 12 and 14:

Winter Flight Service—Coat—To be of same pattern as white service coat, Uniform Regulations U. S. Navy, except that on the front there shall be four patch pockets of the same material as the coat, the two upper pockets being on the breast on each side, 7 inches deep and 6 inches wide, in side measurements, and vertically pleated down the center by a pleat 1½ inches wide, the top of these pockets being on a horizontal line 1 inch below the points of the shoulder; the upper pockets shall be closed by flaps of the same width as the pockets and 1½ inches deep at the ends, curving thence to a point in the center, where the depth shall be 3 inches; the two lower pockets are to be cut bellows style, 9 inches deep, 8½ inches wide at the top and 9½ inches wide at the bottom, inside measurements, the piece to form the bellows is to be 2½ inches wide, inside measurement, one edge to be seamed and stitched to the pocket, the other to be turned in and neatly stitched to the coat, the corners to be mitered so as to make the pocket lie close to the coat, the lower edges of the pocket and bellows piece to be rounded, these pockets to be sewed close to the bottom of the coat. There shall be a flap of two-ply cloth stitched 1 inch above each lower pocket opening 3½ inches wide at the point in the center and curving to 1½ inches wide at each side; there shall be a button hole worked vertically in the point of the flap, the flap to be stitched to the coat on a horizontal line with the bottom button. Extending from the neck at the front of the coat on each side to the top of each upper pocket there shall be two welted gore seams about 1½ inches apart at the collar and 2 inches apart at the top of the pocket. Inside pockets may be added if desired. Material to be of forestry green as prescribed in Uniform Regulations, U. S. Marine Corps, for winter field service.

Breeches—To be of same pattern as winter field breeches, Uniform Regulations, U. S. Marine Corps. Material to be of forestry green.

Trousers—To be of same pattern as undress trousers, Uniform Regulations, U. S. Navy. Material to be of forestry green. To be worn when leggings are not worn.

Major John Purroy Mitchel, former Mayor of New York, recently killed in an airplane accident

Overcoat—To be of same pattern as the Uniform Overcoat Regulations, U. S. Navy. Material will be of forestry green. Shall be knee length and shall have five plain, brown buttons, 1½ inches in diameter, on each front. Lower buttons placed about three inches below the sword belt, the other equally spaced up to the throat. Sleeve stripes shall be brown.

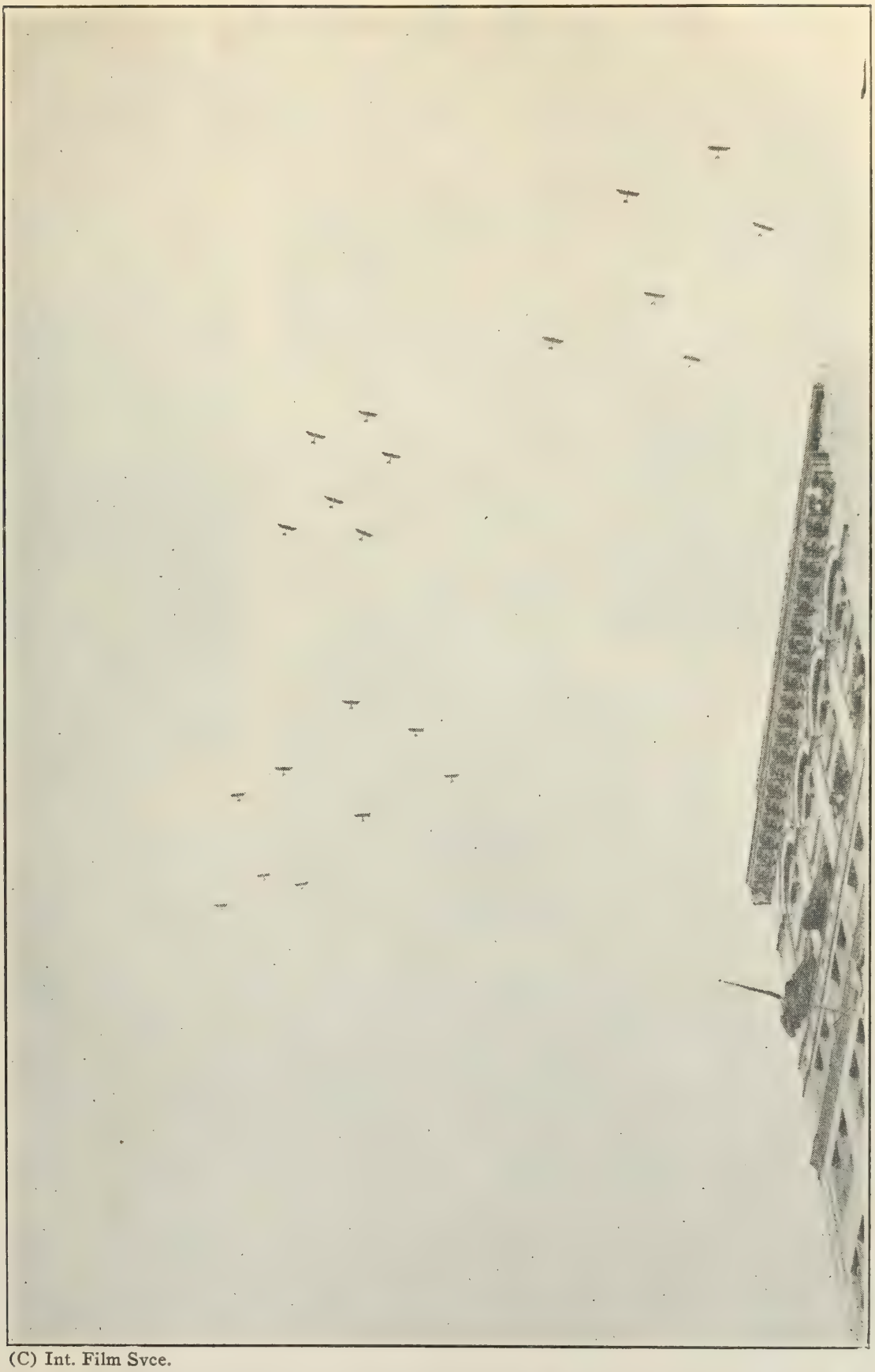
Gloves—Brown.

Caps—Similar to service blue caps, Uniform Regulations, U. S. Navy, except that top will be of forestry green material.

Shoes—High laced shoes of tan leather.

Leggings—To be of tan leather and of the pattern known as "puttee."

Flannel Shirts—Similar to flannel shirts, Marine Corps Regulations.



(C) Int. Film Svce.

In the July 4th celebration New York centered its activities in a monster parade. As the procession passed along Fifth Avenue American military airplanes appeared in flying formation to accompany the column. This view shows 21 American made airplanes over the city

MILITARY AIRMEN

MAJOR WILLIAM THAW

Veteran of Three Years in the Lafayette Escadrille and the First American to Fight in the Air for France Has Donned Khaki for the United States.

IN point of actual achievement in the air the record of Major William Thaw is unique. In the early days of the war Mr. Thaw left his Pittsburgh home and hurried to France to enlist in the aviation service. His preliminary training was accomplished in record time, and in December, 1914, he received his regular appointment to the aviation corps. The first American aviator to go aloft under actual battle conditions abroad, and the first to fly over German territory, his skill was quickly recognized, and even in the early days of the war he was given many important tasks to execute.

At his own request Thaw was sent to Verdun when the air fighting was particularly perilous. Here he carried out many orders involving difficult and dangerous patrol work. Captain Thaw, as he was then known, flew an average of seven hours daily for eleven days. He established a unique record for participating in five air fights in two days. On the second day he shot down a German machine. Shortly after this he was struck in the arm by a German bullet, but continued to fly, although his arm remained stiff from the wound.

Captain Thaw became famous for his daring work in flying for the Lafayette Escadrille. During the time this famous organization was in existence Captain Thaw flew thousands of kilometers over German territory. He brought down his first German early in 1916. For his work with the Escadrille he was awarded the Military Cross by the French Government; among other decorations he has received the War Medal presented by the Aero Club of America for distinguished acts of bravery. His brilliant work in the air also caused him to be appointed chief of the escadrille, the only American to hold this post.

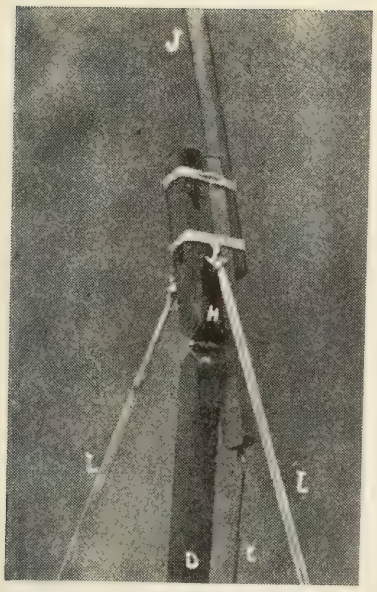
During a visit to America in 1916, Major, then Lieutenant, Thaw took part in the famous "Football Special," which was the first long flight of its kind ever made in the United States. A fleet of twelve passenger-carrying airplanes went aloft at Mineola, and after picking up two more craft at Governors Island, flew to Princeton, N. J., to attend a football game. All the fliers arrived in time for the game and afterwards returned without mishap to New York.

Following America's entrance into the war, when the Lafayette Escadrille was disbanded, he donned the uniform of a Major of our army and has since, under the American flag, waged many successful battles in the air.

Visual Signaling for the Army

The Superiority of Signal Disks Over Semaphore Flags in Code Signaling is Demonstrated

By Lieut. Col. B. O. Lenoir,
Signal Corps, U. S. A.



Signaling machine

SOME interesting experiments in signaling have been made by the writer comparing the relative efficiency of the semaphore flags with the different sizes of very light disks, using the International code. The American Morse code can be used equally as well.

Four different sized disks, 6, 8, 10 and 12 inches in diameter were constructed of small wire. A very light wooden rod from 20 to 30 inches long, ¼-inch thick, ⅞-inch wide at the handle, tapering to ½-inch at the top, was rigidly fastened to the disk by twine, the wooden handle reaching through the wire circle to give it the rigidity which is essential for rapid signaling. Black cloth covered one side of the disk, with white cloth on the reverse side; the white side being used against dark backgrounds and the black side against the light backgrounds.

When the machine is in operation the edge of the disk cuts the air with practically no friction. No front motion is used, only the time spacing as used in American Morse telegraphy is required. The disks weigh from 1½ to 2 ounces, and can easily be operated with one hand, using the telegraphers' combined wrist and arm motion. It is necessary that the disks be rigid, for rapid sending.

With either the American or International Morse code over the short or long distances, the speed is as great as the semaphore, while many men can use the disks more rapidly. Being always extended, they are more easily seen than the semaphore. There is only one disk to operate, as against the two flags of the semaphore. In fast sending with flags the liability of error is greater for some difficulty is encountered in forming the angles properly.

With the 6-inch disk, 15 to 30 words of five letters each can be transmitted clearly for short distances, and with the precision of the telegraph which it resembles.

With the 8-inch disk, good readable signals can be read at 2,000 feet. At this distance, the semaphore is not reliably read owing to the difficulty of keeping the flags extended all the time. With the 10-inch disk, much better signals can be made and read at 2,000 feet, and with the 12-inch disk there is a still greater improvement in visibility. In these tests it was found that glasses are not needed.

It is thought that at 2,000 feet the 8-inch disk is slightly superior to the semaphore and on the principle of the larger the disk, the better the visibility, the 10- and 12-inch disk is far superior.

The superiority of the disk over the semaphore pertains both to visibility and rapidity at 2,000 feet. Twelve to eighteen words of five letters each can be easily read with the naked eye when the disks are used, while the semaphore cannot be seen all the time with the naked eye, owing to the fact that the flags are not fully extended, and again to the fact that the mixture of colors tends toward camouflage. A greater speed than 15 words per minute requires considerable expertness in either code.

Many letters have been received, showing that the writers have used the signal disks with advantage over the semaphore as to speed and visibility. The abolition of the semaphore entirely would simplify signaling in that it would reduce by one language the number of signal languages to be learned intuitively. The term "intuitively" is used, for rapid signaling requires practice so long that sending and receiving are done by intuition. There is no time to think or reason—those who have to think are not experts. Men who can handle only 8 or 10 words per minute cannot be considered expert signalists. There is no short route to the expert grade; it requires practice over a long period of time.

The writer has constructed a sending machine, shown in the accompanying illustration, using large disks at a long distance and operated something like a telegraph key. This machine lessens the labor of sending, for when 100 words or more are sent rapidly with large disks it is tiresome to the sender. The machine is simple and can be easily made. The weight of the whole apparatus including the disk, as used in Seattle, is a little less than 5 lbs. A diagram will be sent to those interested.

Success has also been attained in using only dots and dashes, as in telegraphy, using the disk either by hand or on the sending machine.

Fifteen words a minute can be sent, which is not more rapid than sending by hand, but there is less fatigue. In addition, the movement of the disk is more regular; in sending by hand the movement on the left side sometimes is not enough for the disk to entirely clear the body unless special care is taken.

By having the apparatus made longer, possibly up to a height of 50 feet or more, it could be operated from the bottom of a trench, the disk being at any elevation that may be desired above the trench.

It is requested that those signalists who try the disks for signaling, send their experiences to the writer.

Position of disk to indicate dot

Normal position of disk

Position of disk to indicate dash

High Power Stations

Some Features of the Long Distance Stations of the American Marconi Company

By C. H. Taylor

Engineer, Transoceanic Division, Marconi Wireless Telegraph Co.

(*Continued from July Wireless Age.*)

The chief source of trouble to the commercial operation of long distance stations is the volume and the intensity of the atmospheric disturbances which are always present on the longer wave-lengths. These were found to be

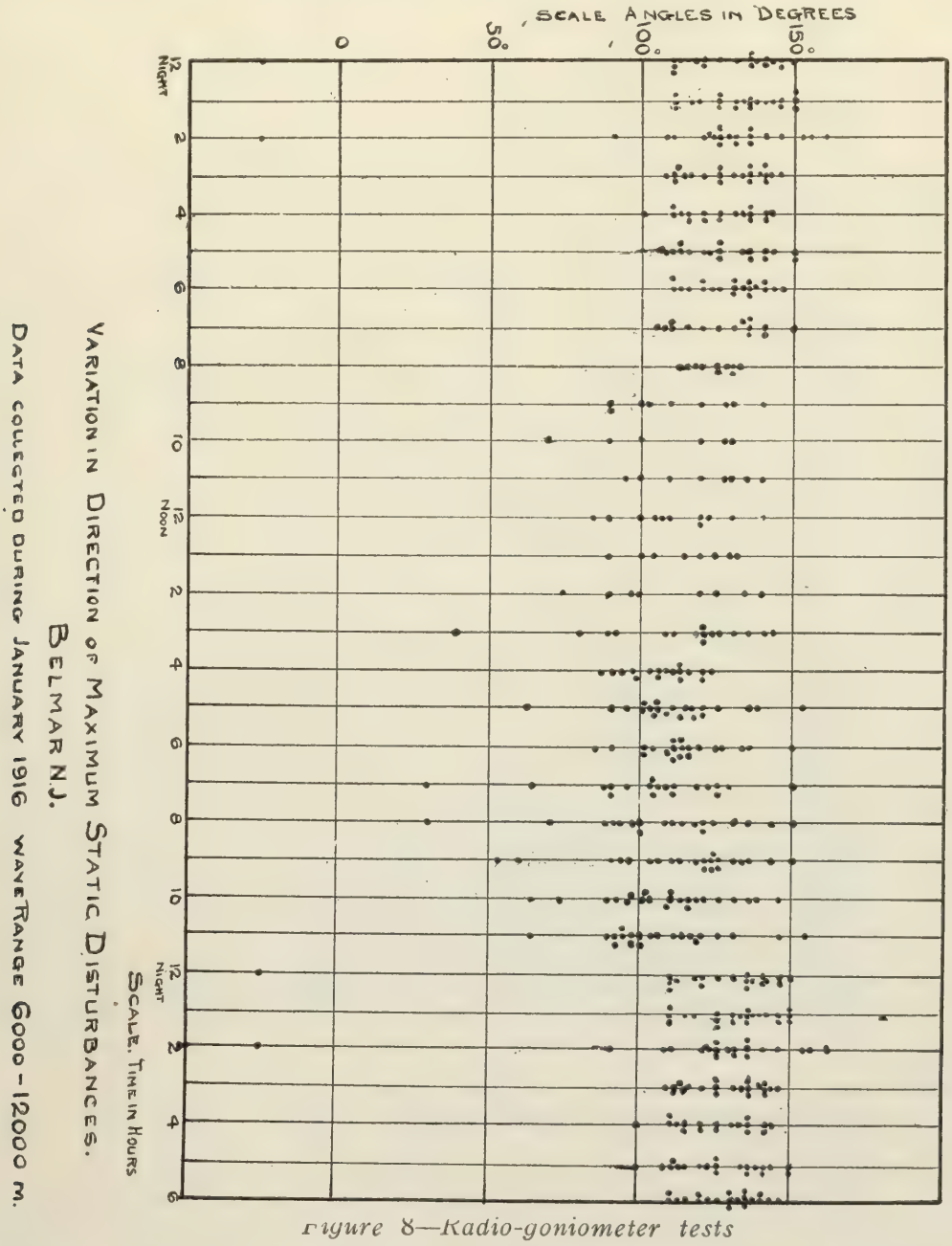


Figure 8—Radio-goniometer tests

exceptionally severe on the long waves proposed to be used at these stations—namely, 6,000 to 16,000 metres, and it was at once realised that the usefulness of these stations for commercial business would depend to a great extent upon the ability to eliminate or minimise the trouble from this source. As stated above, experiments with the antenna did not appear to be the correct line of attack, since the sturb and the signal were diminished in about the same

proportion, yet there is some advantage to be gained from this, since anything that decreases the continuous load on the detector must be of service.

One of the first questions that naturally arises in connection with these sturbs is "Where do they come from?" and it was considered that if their "office of origin" could be located this might help solve the problem of their elimination. For this purpose an investigation has been conducted at the Belmar station, where a directive antenna of the Bellini-Tosi type was erected. A receiving set with a radiogoniometer circuit was installed and continuous watch was kept throughout the last months of 1915 and the early months of 1916. An hourly record of the apparent direction of the maximum sturbs was kept during that period. The antenna was adjusted so that its zero line was 28° 14′ East of North; the zero reading being on the East and the 180 on the West end of the line. The results are shown on the various charts (*See figures 7 and* 8).

At first sight, the results for our first month of this work was not very promising—this is the chart for part of September and all of October—but it will be seen that the greater number of readings showed that the sturbs were travelling past the station in some definite direction. By the help of the daily variation curves it can be seen that the bulk of these sturbs are moving in a direction embraced by the angular range of 90-130, and that outside this range there is another lighter group with an angular range of 50-70, and the other directive readings are scattered around as would be expected. It may also be remarked that the readings showing lack of directivity are more frequent in the first chart than in any of the subsequent ones.

These observations were carried out on a wave-length group from 5,500 to 12,000 meters, and the Arlington 10 p. m. time-and-weather-signals formed the subject thereof. Although it was usual to find no marked alteration in the directivity of the maximum sturb when a wave change was made, yet this is by no means invariably so. This change in the directivity was most marked when swinging from the shorter group of waves to the longest. For instance, a reading on 5,500 gave the angle as 93 and an immediate change to 9,500 gave 120. It was noticed that the shorter wave-lengths favoured the 50-70 region of sturbs. It was also shown that occasions when there were more than one maximum are not infrequent.

At the same time as the noisiest position was being noted, a record of the least noisy was made. This minimum was sometimes rather hard to locate, showing the presence of sturbs travelling in more than one direction even when there was no observable double maxima. The minimum was seldom strictly 90 degrees from the maximum angle, but rarely deviated far from it. In general it seemed to be slightly less than 90 degrees. When more than one minimum is observed, and no double maxima, it was usually found that the maximum was very broad, even when the two minima were each quite sharply defined. It was, however, more usual to have an ill-defined minimum even when the maximum was sharp. The changes in the directivity of the maximum sturb were sometimes sharp enough to follow during the hour; for instance, on October 15th, at 10 p. m., the maximum was at 120; fifteen minutes later it had increased to 122; another ten minutes and it had climbed to 128; after which it fell off and had diminished to 117 by the end of the next fifteen minutes, and continued to decrease, reaching 114 ten minutes later and 110 at 11 p. m.

From these observations we should gather that the bulk of the sturbs at Belmar are due to disturbances travelling by the station in a direction approximately 90 degrees from the zero line, and that there is a secondary source travelling in a direction averaging 60 degrees from the zero line. This latter source appears to be less evident during the winter months.

It would therefore appear that the major portion of the sturbs at Belmar are travelling in a direction that may be roughly designated as across the line of the coast.

At the same time as these observations were being made, record was kept of the goniometer angle at which several of the long distance stations gave max-

(C) Int. Film Svce.

When a German submarine overhauled the Carolina on June 2nd orders were shouted by megaphone to the young man pictured above to stop sending the distress call. Though shells were already bursting about the wireless cabin this New York boy replied that he wasn't taking orders from any skipper but his own and he didn't stop shooting out the SOS until his own Captain came to the radio room and told him to stop. Meanwhile he had received an answer from Cape May station. This plucky American is Erwin W. Vogel, eighteen years old, a former amateur who graduated from the Marconi Institute two years ago

imum audibility and it was found that there was a discrepancy between the true directivity and the apparent directivity of their waves as they passed this station. These results are set out chiefly because of its bearing on the true direction of the sturbs and they must not be accepted as final until further confirmation has been made both at this point, and, if possible, at others. (*See figure* 8.)

At Belmar the deviation between the true direction of a long distance station and the goniometer angle of the direction of its radiated waves as they travel by that station is sometimes considerable. This variation appears to depend, to some extent, upon the electrical clarity of the atmosphere. For instance, when the signals from Glace Bay station are at their normal or above their normal strength their apparent direction lies close to the average of a number of observations around the true direction; but if they are much below their normal strength then the deviation may be large, both from the true and the average directions.

Unfortunately there are few stations to the west of Belmar upon which a series of daily observations could be made, and there is thus a very big gap in these records.

No especial variation was noticed during the sunrise and sunset periods beyond that already recorded for periods of weak signals at other times during the day. And it is curious to note that the directivity of the Arlington wave was furthest from the true bearing of that station on a night when a tropical storm warning was broadcasted.

So far as can be seen, a change of wave length at the transmitting station does not affect this deviation except in the event of the received signal being weakened below normal.

No observations of this nature have been taken on the Pacific coast so far as I am aware, and a series of these should be made both for that coast and for an isolated spot like Honolulu.

It is quite frequently found at the stations at Honolulu that there is a certain wave-length selectivity to the sturb. When the short wave stations are being bothered very badly the long wave stations may be reporting this trouble normal or even below normal. During the local storm season this sturb trouble is heavy on the long waves and varies with the storms. So long as the trade winds blow and the atmospheric conditions are unchanged there is a marked absence of this type of trouble. But while there is a daily change in the weather conditions the sturbs are present in great force just as they are on the coast.

At the Marshall station in California, trouble from sturbs is heavy throughout the summer months and gets lighter during the winter. During the heavy wind storms which are quite common during the spring at this station there seemed to be some relation between the intensity of the sturb and the barometer reading. During very heavy gales when the wind was varying in velocity very rapidly the strength of the signals and of the sturbs appeared to follow the fluctuations of the barometer. On one occasion the barometer needle was oscillating between 29.44 and 29.52 at a rate of about 10 cycles per minute. When the wind increased suddenly in velocity, the barometer fell and the strength of the sturbs and of the signals decreased in strength to a remarkable degree, and returned to normal as soon as the gust passed. This phenomenon recurred with several of the wind storms when the local weather bureau reported a wind velocity between 90 and 100 miles per hour, and the wind was very gusty. During the summer months observations on the movements of the barometer needle and the prevalence of sturbs were made but definite relation could not be established.

The effect of the humidity was also noted, but here again the results were disappointing. Without doubt a much more extended series of observations must be made upon both of these points.

Interference is another problem that has already assumed nearly as much importance as that of the sturbs and will undoubtedly increase in importance as the number of stations radiating energy in any considerable quantity is increased in any area. If the receiving circuit is one that can be readily set into vibration, then

it will be impulsed by waves of very different lengths and the detector circuit may respond. The problem would be more simple if (*a*) all these signals were of the same order of loudness when the circuits are in resonance with their wave-lengths, if (*b*) they all had the same shape of wave-train, and if (*c*) their wave-lengths were not all packed closely together. Unfortunately the interference that is the cause of most of the trouble usually comes from nearby power stations employing considerable power a few miles off and working on a wave-length that

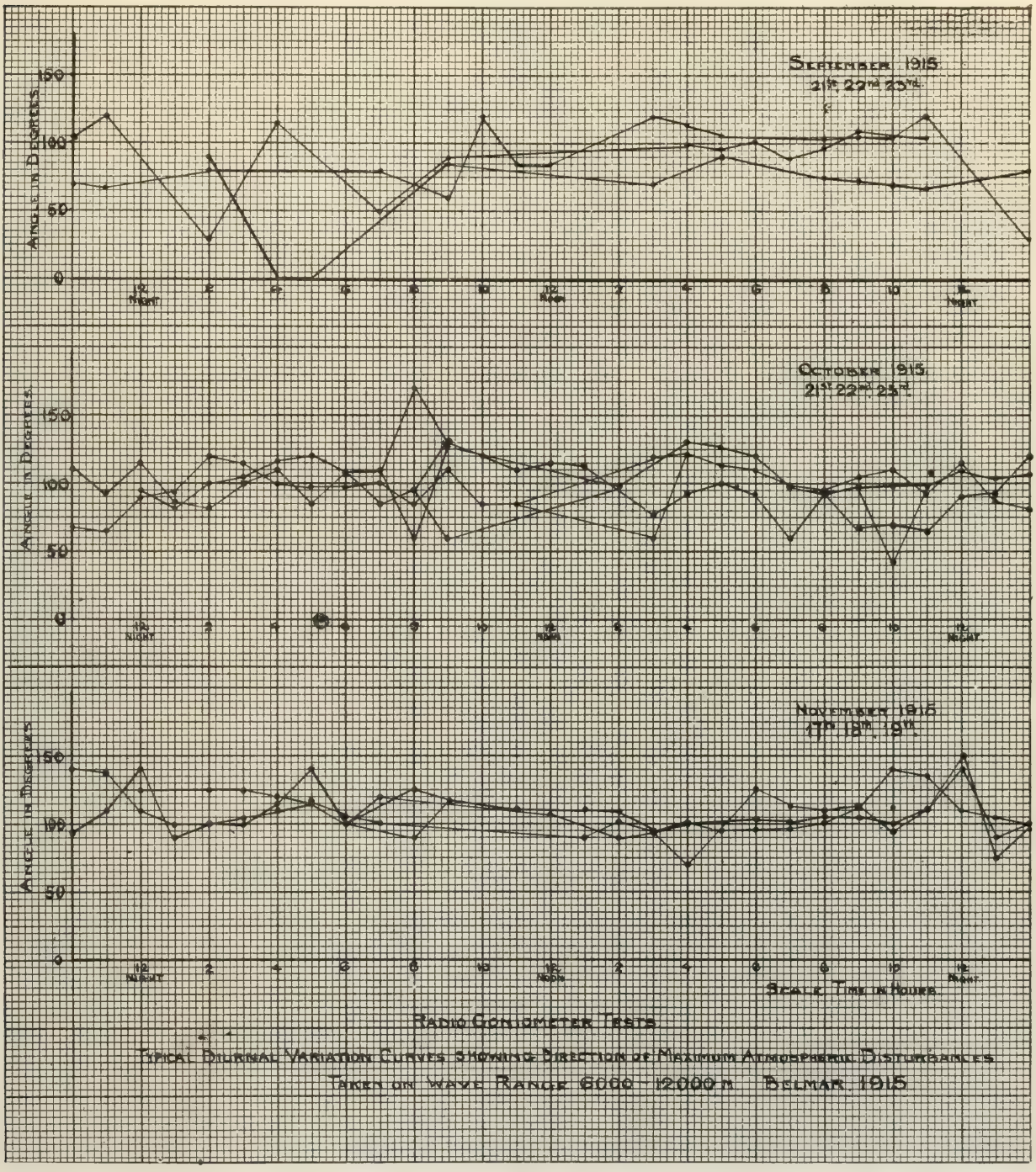


Figure 9—Typical diurnal variation curves showing direction of maximum atmospheric disturbances

is not very different from that being used by the station about 2 or 3,000 miles off, the signals of which are to be copied.

There is a wide difference in minimising interference from a nearby spark and a nearby arc station. In all modern spark stations the emitted wave trains produce a more or less clear musical tone in the telephones of the receiver. Change of wave length is not indulged in by commercial spark stations to any marked extent, so adjustments can be made and set up to remain indefinitely.

But with a local arc station one has much more trouble to guard against. In addition to the working wave there is also the compensating wave and the noises of the arc. The compensating wave area sometimes seems to be unnecessarily broad, and if it is close to the transmitting wave the two may overlap and make a very broad disturbance area. As a sample of these wave areas the following taken in November last may be cited. (*See figure 9.*) The audibility throughout these areas was 20 plus. The tuning condenser ranges were for the lower group from 10 to 42 and for the upper group from 60 to 96; the total range of the condenser is 0 to 180. The wave-lengths corresponding to these adjustments were 5,000 to 7,870 and 8,980 to 10,990 meters. Frequent wave changes make it difficult to adequately protect a circuit, but these frequent changes are of extreme use to one who is watching out for opportunities for the study of this problem.

The effect of the arc-upon-spark signals varies with the difference in length between the two waves. If identical or closely similar, there is a smothering effect upon the distant spark station's signals if these are quite weak; in the worst cases the spark signals cannot be heard through the arc noises. If the two wave lengths are near to one another most pronounced beats will be heard; the spark appears to throb, a result that makes the signal rather difficult to read. A distant arc, one the operations of which are not particularly noticeable in the receiver, will also cause this throbbing, and in such cases there is no audible evidence of the arc yet the signal seems to fade and grow as would be the case if there were a swinging fault on the line. In both of these cases the spark signals can be read, even if the incoming signal is relatively weak. At other wave-lengths the arc will heterodyne the spark signal and improve its audibility in the well-known manner due to this method of reception. Unfortunately, the arc station would not maintain this wave-length and assist the spark work as often as could be desired.

In a general way, it seems better to overcome the interference from this source by tone working, as the musical note is more readily followed through the arc noises than the tones derived by the heterodyne method of reception. But there are many occasions in which the ability to alter the pitch of the signal more than compensated for the other defects of this method, and the increase in the audibility of the signals assisted the operator.

Working on long waves has demonstrated that stations at a moderate distance can impulse these receivers in a troublesome manner if they—the distant station—are being operated upon a wave that is a submultiple of the wave for which the receiver is tuned. It has also been noted that this trouble increases if the long wave is some even multiple of the shorter one. On one occasion it was found that a certain station was quite troublesome from time to time although it was at a moderate distance away, and on other occasions it was scarcely audible. So far as could be ascertained no changes were being made at that station. But wave-length changes were being made at the Marconi stations, and it was soon evident that the interference was most troublesome when these were tuned to a wave length that was an even multiple of the wave-length of the disturbing stations, and was less troublesome when the received wave was either an odd multiple or not strictly related to their wave.

Advantage was taken of this feature in some work on the minimisation of these and sturb troubles. The antenna circuit may be tuned to a multiple of the wave length to be received and the secondary circuit set at the correct wave length; then it will be found that the troubles from sturbs fall off at a greater rate than does the strength of the signal. In this case amplification can be resorted to with advantage.

An alternative method is one in which the antenna is made to be less readily impulsed, a procedure that decreases its receptivity, and the gain in its relative freedom from the above troubles may be utilised by the amplification of the incoming signal above that which is possible on circuits that are crowded with sturbs.

Finding Your Way Across the Sea

A Practical Instruction Course in Navigation

By Captain Fritz E. Uttmark

ERRATA

Errors will occur in the process of turning manuscript into printing. The following introductory paragraph was omitted on page 837, July Wireless Age:

"Before proceeding further it will be of interest to record a few facts about the earth. We introduce a chapter taken from Young's 'Astronomy.' This work is by one of my favorite authors on the subject."

CHAPTER VIII.

Copyright, 1918, Wireless Press, Inc.

Day's Work (*Continued from June Wireless Age*)

Example for Practice

	Compass Course	Wind	Leeway	Deviation	Variation
1.	N W	N N E	1 pt.	½ pt. E	½ pt. W
2.	E N E	North	2 pt.	½ pt. E	½ pt. W
3.	N W ½ W	N N E	½ pt.	¼ pt. W	½ pt. W
4.	South	W S W	¾ pt.	¼ pt. W	1 pt. W
5.	N 30° E	E S E	10°	5° W	10° E
6.	310°		15°	12° E	3° W

Answer

No. 1.....N W by W
No. 2.....East
No. 3.....W N W
No. 4.....S S E
No. 5.....N 5° E
No. 6.....333°

Explanation of Tables I and II Bowditch

Table I contains the Difference of Latitude and Departure corresponding to distances not exceeding 300 miles and for courses to every ¼ point of the compass.

Table II is of the same nature but for courses consisting of all degrees and including distances up to 600 miles.

In Table I all courses from ¼ point up to 4 points are found and taken out from the top of the page. For courses from 4 points up to 7¾ are taken out from the bottom of the page.

In Table II courses from 1° to 45° are found and taken out from the top of the page and courses from 45° to 89° are found and taken out from the bottom of the page. Note that the latitude and departure columns are reversed when looking from the bottom of the page. For full explanation of the tables see plane sailing, Middle Latitude Sailing and Mercator Sailing (see previous chapter). The Tables I and II Bowditch may be employed in solving all the problems relating to right triangles.

Dead Reckoning (Day's Work)

Example. From latitude 39° 40′ 50″ N and longitude 72° 40′ 30″ W a vessel sails the following courses and distances:

Compass Course	Tack	Leeway	Deviation	Variation	Distance
S S E	S.T.	½ pt.	0	½ pt. W	35
S by E ½ E	S.T.	½ pt.	0	½ pt. W	40
S by E ¾ E	S.T.	½ pt.	½ pt. W	½ pt. W	25
S S E ¼ E	S.T.	¾ pt.	¾ pt. W	¾ pt. W	20

Required latitude and longitude by D. R., also course and distance made good.

Solution

Compass Course	Tack	Leeway	Deviation	Var.	Error	True Course	Dist.	Diff.L. S.	Dp. E.
S S E	St.	½ pt. W	0	½ pt. W	1 pt. W	S E by S	35	29.1	19.4
S by E ½ E	St.	½ pt. W	0	½ pt. W	1 pt. W	S S E ½ E	40	35.3	18.9
S by E ¾ E	St.	½ pt. W	½ pt. W	½ pt. W	1½ pt. W	S E ¾ S	25	20.1	14.9
S S E ¼ E	St.	¾ pt. W	¾ pt. W	¾ pt. W	2¼ pt. W	S E ½ E	20	12.7	15.5
								97.2S	68.7E

Latitude Left	39°	40′	50″	N	Longitude Left	72°	40′	30″	W
Difference of Latitude .	1	37	12	S	Difference of Longitude	1	28	00	E
Latitude by Dead Reckoning	38°	3′	38″	N	Longitude by Dead Reckoning	71°	12′	30″	W
Latitude Left	39°	40′	50″	N					
Latitude by Dead Reckoning	38	3	38						
Divided by ...2.....	77°	44′	28″		Course Made Good .....S 35° E				
Gives Middle Latitude ..	38°	52′	(39°)		Distance Made Good .....119 miles				

From latitude 30° 20′ 40″ North and longitude 67° 43′ 57″ West, a ship sailed N 5° W by compass. Distance 180 miles. Variation 4° West. Deviation 7° East.

For 10 hours the ship was in a current flowing N 45° E (magnetic) at the rate of 2 miles per hour. Variation of compass 5° West.

For 6 hours ship was hove-to on the starboard tack, ship's head coming up to East and falling off to N 68° E. Leeway 20°. Variation 6° W. Deviation 4° West. Ship forged ahead at the rate of 1½ knots per hour.

Required latitude and longitude of the ship, also true course and distance made good.

Solution

Compass Course	Tack	Leeway	Deviation	Var.	Error	True Course	Distance	Diff.L. N	Depar. E	Depar. W
N 5° W			4° W	7° E	3° E	N 2° W	180	179.9		6.3
N 45° E			5° W	0	5° W	N 40° E	20	15.3	12.9	
N 79° E	St.	20° W	6° W	4° W	30° W	N 49° E	9	5.9	6.8	
								201.1N	19.7	6.3
									6.3	
									13.4E	

Latitude Left	30°	40′	20″	N	Longitude Left	67°	43′	57″	W
Difference of Latitude..	3	21	6		Difference of Longitude		16′	00″	E
Latitude by Dead Reckoning	33°	41′	46″	N	Longitude by Dead Reckoning	67°	27′	57″	W
Latitude Left	30°	20′	40″	N					
Latitude by Dead Reckoning	33	41	46						
Divided by 2	64°	62′	26″		Course Made Good ..... N 4° E				
Gives Middle Latitude..	31°	1′	13″	W	Distance Made Good.....202 miles				

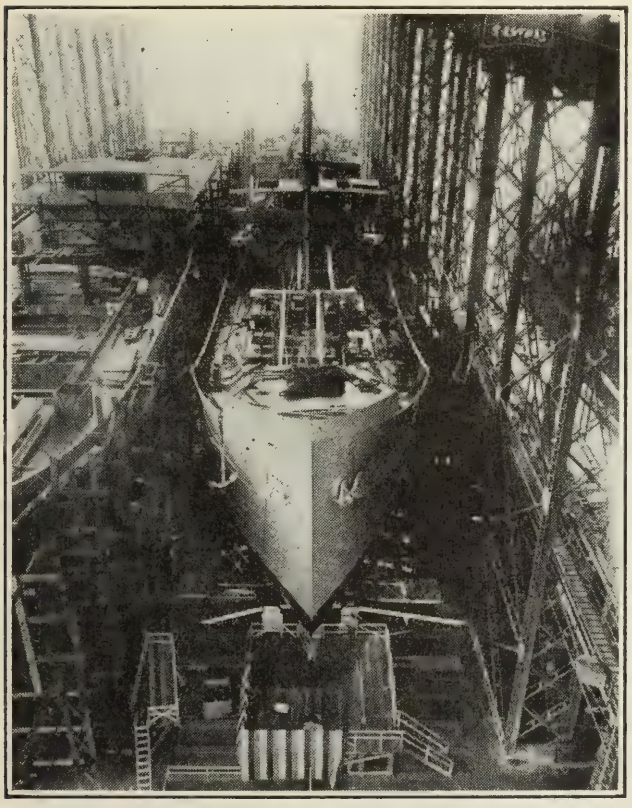
(*To be continued.*)

Navigation News

Seized German Ships Improved

News of the safe arrival in France a few weeks ago of 16 German ships, seized in American waters shortly after the declaration of war by the United States, caused officials of the Morse Dry Dock & Repair Company, Brooklyn, a thrill of pleasure, owing to the fact that several of the vessels were restored to usefulness by the Morse Company after their machinery had been damaged by the German crews to put the ships out of commission.

The German scheme of ruin was shrewd-



Collier Tuckahoe built in 27 days, being a world record for speedy ship construction

ly devised and arranged, from plugging the steam pipes to the burning up of boilers by dry firing.

Patching and welding was determined upon as the method of repairing the damage, and the last of the fleet was finished ready to be ordered into service, as a Thanksgiving gift to the nation. Three methods of patching the broken marine engines were used: electric welding, oxy-acetylene welding and ordinary mechanical patching. In no case were repairs to the propulsive machinery delayed beyond the time necessary to equip the vessels as transports, in which service they are being used. The most important ships handled by the Morse Company were the "Koenig Wilhelm II" and the "Gosser-Kurfurst."

Forty-two New Concrete Ships

Five yards for the building of concrete ships and the construction of a total of 42 new concrete ships have been authorized by the United States Shipping Board.

Of these 42 concrete ships, contracts for 18 already have been given by the Emergency Fleet Corporation. Contracts for the building of the remainder will be let shortly. These 42 concrete ships nearly all will be tankers, of 7,500 tons each, with a capacity of 50,000 barrels of oil. Each of the 7,500-ton ships will have 2,800 horse power. Others of the concrete ships are cargo ships, of 3,000 and 3,500 tons. The 42 concrete ships will have a total of 298,500 dead-weight tonnage.

The five Government yards will be located at various points on our coasts. Construction of one of these yards at Wilmington, N. C., is already under way. Others will be at Jacksonville, Fla., Mobile, Ala., and San Diego, Cal. The fifth yard is that at San Francisco, of the San Francisco Shipbuilding Company, which built the "Faith," the first concrete vessel. This company has been given an agency contract for eight concrete ships. There are also two private concrete shipbuilding yards, one at Brunswick, Ga., the other at New York City.

Electric Propulsion for New Vessels

Plans for the new steel steamers contemplate the purchase of 100 electrical propelling sets, suitable for large-size cargo steamers, and of the type satisfactory in naval vessels. This is an innovation for merchant ship construction. The experience of the naval vessels, however, indicate a remarkable economy and dependable action from electrical propelling machinery. The ease of manipulation that is a feature of this mechanism also is an attraction, it being said that running an electrically propelled ship is not much more difficult than running a trolley car.

The problem of obtaining men to act as electrical engineers on the vessels has been solved, it is believed, by the decision to ask for the services of men in charge of big power plants throughout the country. As soon as these men get their "sea legs" they will be qualified to take charge of the electrical apparatus on the new ships.

(C) Press Ill. Svce.

A view of a naval gun crew at work below decks is an oddity, added interest being given in this instance by the head protection. The two men in the center are swabbing the piece preparatory to the insertion of the new projectile, held by the man on the left, as the gunner on the right stands in readiness to close the breech

THE DYNATRON

A Vacuum Tube Possessing Negative Electric Resistance*

By Albert W. Hull, Ph.D.

Research Laboratory, General Electric Company, Schenectady, New York

(*Continued from June* WIRELESS AGE)

The wave-form depends on the ratio of inductance to capacity and resistance. According to theory we should expect a perfect sine wave when $L \div C$ is very nearly equal to Rr (since in this case the circuit fulfills the condition of simple harmonic motion), with increasing distortion as the ratio of $L \div C$ to Rr increases. As this is a question of considerable importance, a series of oscillograms was taken with different ratios of $L \div C$ to $R\ r$. They are shown in figure 12. The circuit is that of figure 11, except that a secondary circuit is coupled inductively with the primary in order to show the form of the wave in a coupled circuit. In each photograph the upper curve gives the current in the coupled circuit, the middle curve the current in the primary circuit, and the lower curve a 40 cycle timing wave. Air inductance and paraffin condensers were used.

Films A to D show the effect of increasing the ratio $L \div C$, keeping R and r constant. As $L \div C$ increases the primary wave changes from a pure sine wave (film A) to a very slightly distorted wave (film B) and finally to a very badly distorted wave (film D). For comparison with curve D, film E was taken under the same conditions and the same frequency, but with a proper ratio of $L \div C$. It is a good sine wave. It is to be noted that the oscillation in the coupled circuit is a fair sine wave, even when the primary is badly distorted.

6. DYNATRON IN INDUCTIVE CIRCUIT WITH IMPRESSED PERIODIC ELECTROMOTIVE FORCE

If a periodic e.m.f, represented by $e_0 \cos \omega t$ be impressed upon the circuit of figure 11, the forced oscillations which it impresses upon the circuit may attain a much greater value than in a circuit containing no dynatron. This can best be seen from mathematical analysis. The equations of the circuit are:

$$I R + L\frac{dI}{dt} = E - e_0 \cos \omega t$$

$$i = \frac{E}{r} + i_0$$

$$I + i = -C\frac{dE}{dt}$$

whence

$$\frac{d^2E}{dt^2} + \left(\frac{R}{L} + \frac{1}{Cr}\right)\frac{dE}{dt} + \frac{1}{LC}\left(1 + \frac{R}{r}\right)E + \frac{i_0}{LC}(R + L) = \frac{e_0}{LC}\cos \omega t$$

*Reprinted by permission from the **Proceedings of the Institute of Radio Engineers.**

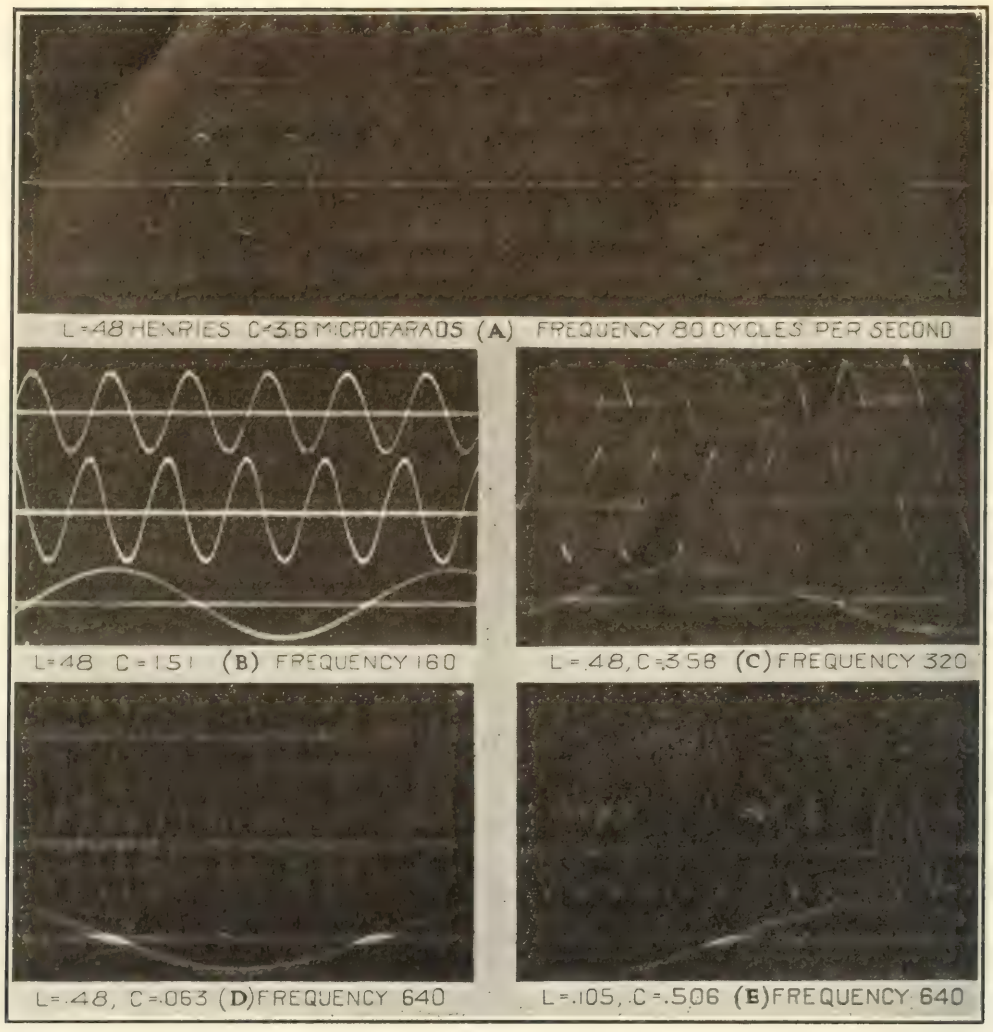

L=48 HENRIES C=3.6 MICROFARADS (A) FREQUENCY 80 CYCLES PER SECOND
L=48 C=151 (B) FREQUENCY 160
L=.48, C=358 (C) FREQUENCY 320
L=.48, C=.063 (D) FREQUENCY 640
L=.105, C=.506 (E) FREQUENCY 640

Figure 12—Effect of Capacity on Wave Form in Oscillating Dynatron
The middle curve in each film is the current through the dynatron, the upper curve the current in the coupled circuit, the lower curve a 40-cycle wave for comparison

and

$$E = -\frac{i_o(R+L)}{1+\frac{R}{\bar{r}}} + A\,\varepsilon^{-\frac{1}{2}\left(\frac{R}{L}+\frac{1}{C\bar{r}}\right)t}\cos\left\{\sqrt{\frac{1}{LC}-\left(\frac{R}{2L}-\frac{1}{2C\bar{r}}\right)^2}\,t-a\right\} + \frac{e_o\cos(\omega t-\theta)}{\sqrt{\left(1+\frac{R}{\bar{r}}-LC\omega^2\right)^2+\omega^2\left(RC+\frac{L}{\bar{r}}\right)^2}} \qquad (4)$$

if

or

$$\frac{1}{LC} > \left(\frac{R}{2L}-\frac{1}{2C\bar{r}}\right)^2$$

$$E = -\frac{i_o(R+L)}{1+\frac{R}{\bar{r}}} + A\,\varepsilon^{\left[-\left(\frac{R}{2L}+\frac{1}{2C\bar{r}}\right)^2+\sqrt{\left(\frac{R}{2L}-\frac{1}{2C\bar{r}}\right)^2-\frac{1}{LC}}\right]t} + B\,\varepsilon^{\left[-\left(\frac{R}{2L}+\frac{1}{2C\bar{r}}\right)^2-\sqrt{\left(\frac{R}{2L}-\frac{1}{2C\bar{r}}\right)^2-\frac{1}{LC}}\right]t} + \frac{e_o\cos(\omega t-\theta)}{\sqrt{\left(1+\frac{R}{\bar{r}}-LC\omega^2\right)^2+\omega^2\left(RC+\frac{L}{\bar{r}}\right)^2}} \qquad (5)$$

if $$\frac{1}{LC} < \left(\frac{R}{2L} - \frac{1}{2C\bar{r}}\right)^2$$

where A, B, a, and θ are constants, with the usual meanings.

In either case, provided $R<r$, the amplitude of the forced oscillations is

$$\frac{e_o}{\sqrt{\left(1+\frac{R}{\bar{r}}-LC\omega^2\right)^2+\omega^2\left(RC+\frac{L}{\bar{r}}\right)^2}}$$

and can be made as large as desired (since $\bar{r}$ is negative) by making

$$\left.\begin{aligned} Rr &= \frac{L}{C} \\ \frac{R}{r} &= 1-LC\omega^2 \end{aligned}\right\} \qquad (6)$$

The first condition is equivalent to zero damping. The second shows that for maximum sensitiveness the frequency ω must be equal to $\sqrt{\frac{1}{LC}\left(1+\frac{R}{\bar{r}}\right)}$, which is the natural frequency of the system when its damping is zero.

It is to be noted that the sensitiveness of the system is the same whether the damping term $\frac{R}{L} + \frac{1}{C\bar{r}}$ is positive or negative. If it is positive, the natural oscillations of the system soon die out, leaving only the forced oscillation given by (4) and (5). If it is negative, the system will generate oscillations of its own of a frequency $\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\left(\frac{R}{2L}-\frac{1}{2C\bar{r}}\right)^2}$ slightly different from ω, in addition to the oscillations of frequency ω given by (5), and these two will produce heterodyne interference. The application of this to radio receiving is discussed below.

7. The Effect of a Magnetic Field

A profound change in characteristics is produced by placing the cylindrical type of dynatron shown in figure 2 in a magnetic field parallel to the axis of the cylinder. The electrons from the filament, which in the absence of the magnetic field move in nearly straight lines to the anode and pass freely through its holes (figure 13 a), are constrained by the field to move in spirals, and strike the anode more or less tangentially (figure 13 b), so that a much larger proportion are

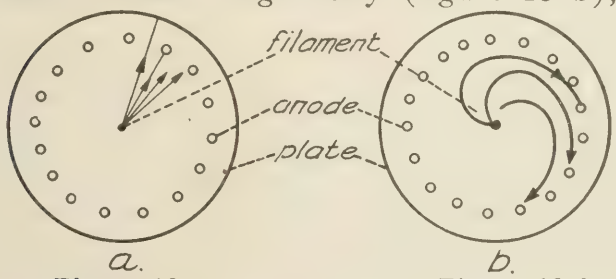


Figure 13 a *Figure* 13 b

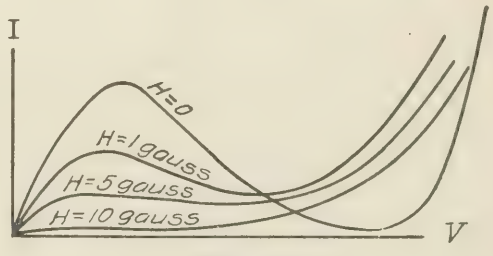


Figure 14

stopped by it. The result is to diminish greatly the number of electrons reaching the plate. Superimposed upon this effect is a restraining effect of the field upon the secondary electrons which try to leave the plate, resulting in a change from negative resistance to positive resistance characteristic.

These effects are shown in figure 14, where each curve represents the voltage-current relation of the dynatron in a definite field. It will be seen that as the field increases the curves become lower and flatter, and soon lose their negative slope altogether. It is thus possible, by varying the magnetic field, to control the behavior of the dynatron. This method of control is especially applicable to the radiophone, as will be explained later.

8. The Pliodynatron

An electrostatic field may be used instead of a magnetic field to control the number of electrons reaching the plate. It has been shown (see figure 6) that the effect of changing the number of electrons leaving the filament, by varying its temperature, is to change the negative resistance without affecting the other characteristics of the current voltage relation. If the temperature of the filament could be easily and rapidly changed, this would be an effective means of controlling the dynatron. The same result may be accomplished, however, by the electrostatic action of a grid close to the filament; that is, by the application of the pliotron principle. A dynatron which thus utilizes the pliotron principle is called

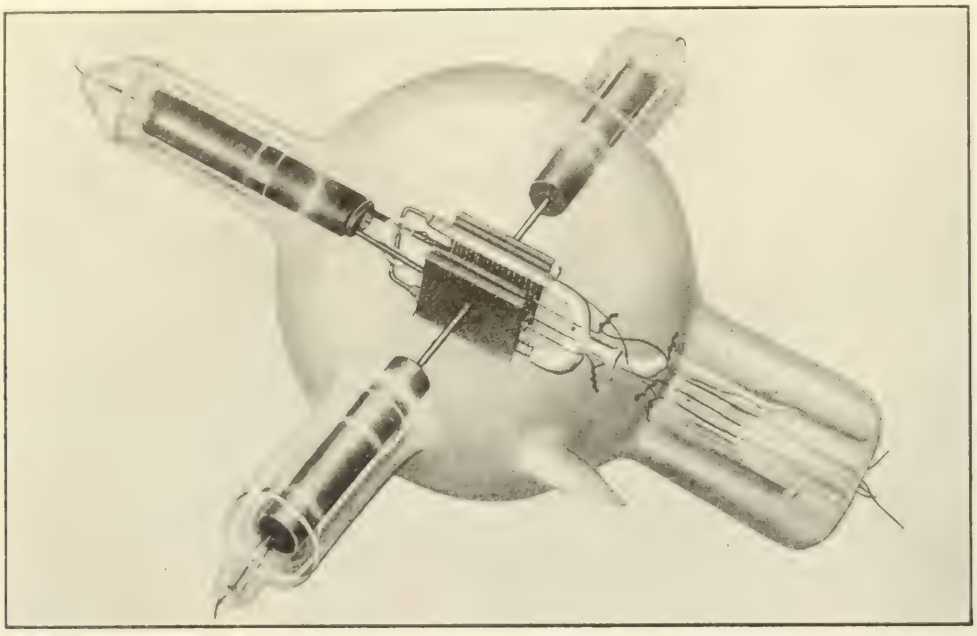


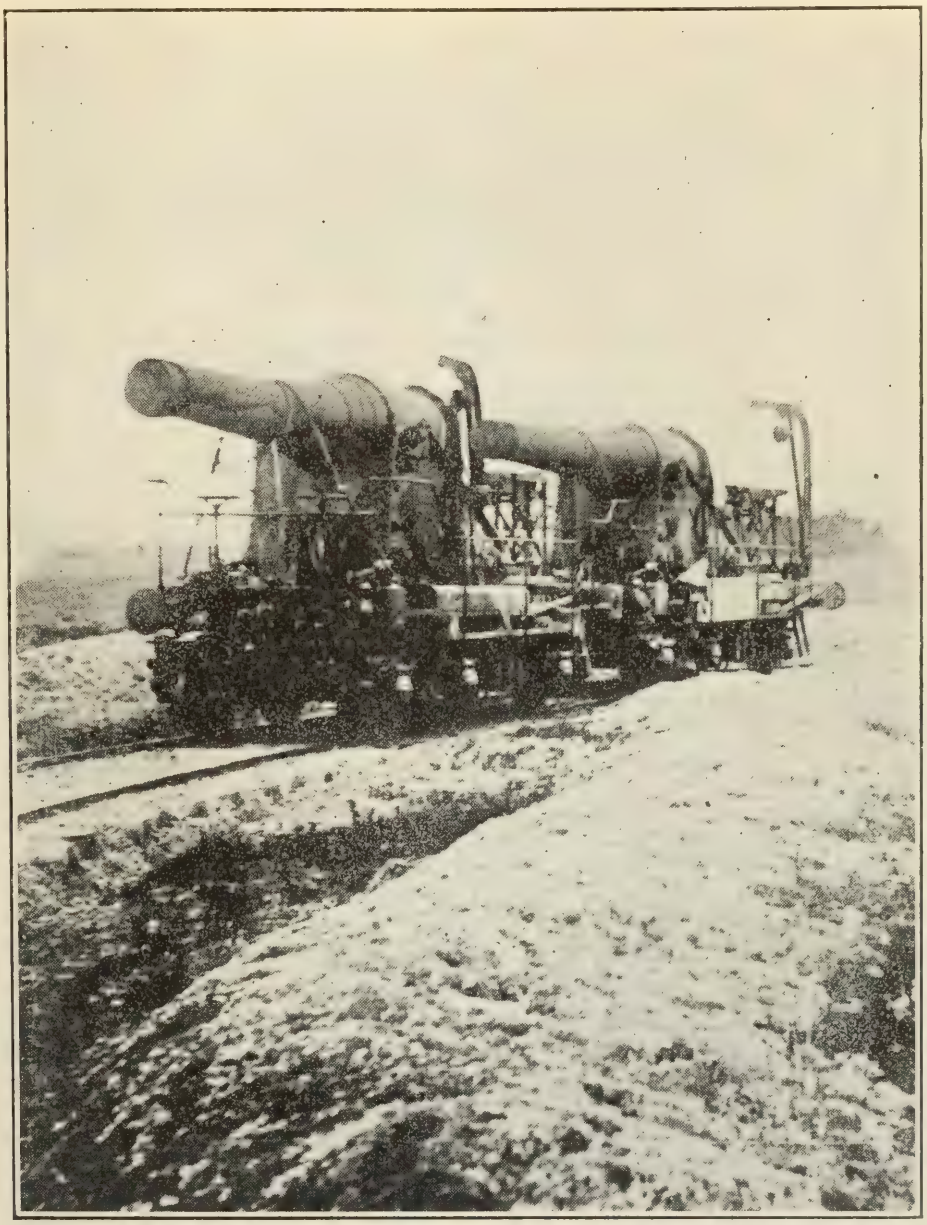
Figure 15—General Electric Company Pliodynatron

a *pliodynatron*. Its construction is the same as that of the simple dynatron with the addition of a "control member," which may be a grid surrounding the filament (figure 2, g) or a metal rod inside the (spiral) filament (figure 2, f).

Its relation to the pliotron can be most clearly seen in the "plate type" of pliodynatron, a photograph of which is shown in figure 15. It is identical in construction with the pliotron except for the addition of the perforated anode.

The characteristics of the pliodynatron can be seen from figure 6, if for filament temperature we substitute grid potentials. The steepness of the curve increases, that is, the negative resistance decreases, with increasing grid potential. The relation is capable of more exact statement: It is known that in the pliotron, with constant anode voltage, the number of electrons leaving the filament is proportional to grid potential over a wide range, and this must be true in the pliodynatron, where the anode voltage is always constant. It may be shown, both theoretically and experimentally, that the negative resistance is inversely proportional, over a wide range, to the total number of electrons leaving the filament. The negative resistance is therefore inversely proportional to grid potential. The behavior of the pliodynatron in circuits containing resistance, inductance and capacity is therefore given by equations (1) to (6) if we replace R in these equations by $R_0 \div v$, where R_0 is a constant and v the potential difference between grid and filament.

The negative resistance of the pliodynatron makes it a powerful amplifier. An increase of grid potential, by increasing the current through the load in the plate circuit and hence the voltage drop over the load, lowers the voltage of the plate. In the pliotron this lowering of the plate voltage tends to decrease the plate current, and thus opposes the effect of the grid. In the pliodynatron, however, a decrease in plate voltage means an increase in current, which may be very large



(C) Press Ill. Svce.

All preconceived notions of the conduct of warfare seem to have gone topsy-turvy in the present conflict. The photograph shows guns of large calibre mounted on specially constructed railway cars for easy mobility, thus competing with the lighter pieces of the field artillery. Guns of the type illustrated were mainly used, before the present war, in fixed positions for coast defense; they are now available for quick transportation to the front to give very material aid in the heavy bombardment which precedes an attack on the trenches. Many thrilling duels have been thus fought with the enemy prior to attack, the monsters on opposing sides endeavoring to put each other out of business by a well directed shot according to the fire data supplied by wireless from observation airplanes

if positive and negative resistance are nearly equal. This will be clear from figure 16, where the curves marked v_1 and v_2 represent the current voltage relation for the grid voltages v_1 and v_2 respectively of a pliodynatron and a pliotron. If we start with an initial current of i_1, corresponding to plate voltage E_1, and raise the grid voltage from v_1 to v_2, the current tends to rise to i_2. On account of the decrease in plate voltage, however, the pliotron current will rise to some smaller value i', while the pliodynatron current will rise to a much larger value i''. The advantage to be gained in this way may be large, if the resistance in the circuit obtained with a pliotron is about 15-fold, while with a pliodynatron we have is high. For example, the maximum aperiodic voltage amplification thus far obtained 1000-fold.

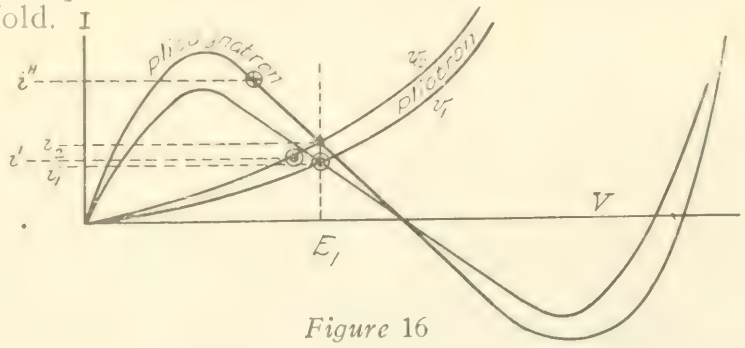


Figure 16

A better method of representing the characteristic behavior of the pliodynatron is, instead of plotting the current to the plate against plate voltage, to plot it against the total voltage across plate and series resistance, as in curve E, figure 8. A series of such plots, for different grid potentials, is shown in figure 17. The voltage plotted is now constant, being that of the battery, and for any given value

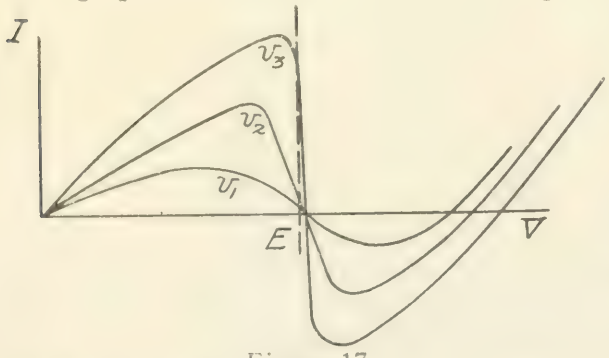


Figure 17

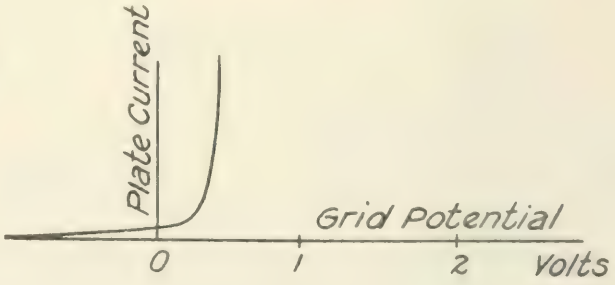


Figure 18

E we obtain the currents corresponding to different grid potentials from the intersections of the curves with a vertical line through E. If E is taken just to the left of the point where the curves cross the axis, the current will increase at first slowly and then very rapidly with grid potential, as shown in figure 18. The amplification is, under these circumstances, both asymmetric and high, and the tube should constitute a good radio receiver. This is discussed more fully in Section 14 below.

Applications of the Dynatron to Radio Work

9. Dynatron as Generator of Radio Waves

It has been shown in section (5) that the dynatron always oscillates providing $Rr < \frac{L}{C}$, where R and r are the positive and negative resistance, respectively, of the circuit, L the inductance and C the capacity. The frequency of oscillation is approximately $\frac{1}{2\pi\sqrt{LC}}$, and may be given any value from 1 to 10,000,000 by changing the inductance and capacity alone. It has also been shown that for low frequencies the oscillations are very nearly pure sine waves provided $L \div C$ is not too great compared with Rr. Theory indicates that this should be true for all frequencies, and a search for harmonics at radio frequencies has verified the expectation.

The dynatron therefore satisfies all the requirements of a radio generator, and has the advantage that its operation is invariable and free from lag, and that the frequency may be given any value by changing a single inductance or capacity. Its oscillations may be controlled either by opening and closing the main circuit, or by changing any one of the four factors L, C, R, and r in accordance with the condition of oscillation given above. Its efficiency is low, probably less than 50 per cent. under best conditions. This is not, however, a serious limitation, except as regards the cost of power, since the tubes are capable of running very hot without deterioration. The maximum output at radio frequency of the tubes thus far constructed is about 100 watts, but no effort has been made to develop a high power tube.

It is generally necessary to transform the radio energy by means of a coupled circuit. In the discussion thus far the effect of such a coupled circuit on the oscillation has been neglected. The calculation for the case of inductively coupled circuits is not easy, but it may be shown experimentally that conditions similar to those derived above hold, even when the coupled circuit absorbs nearly all of the energy.

10. Pliodynatron as Radio Telephone

The simplest method of controlling the oscillations of the dynatron is to vary the negative resistance, by means of a grid around the filament, as in the pliodynatron. It has been shown in Section (8) that the negative resistance of the pliodynatron is inversely proportional to grid potential. Hence if the ratio of inductance to capacity and resistance be initially just large enough to produce oscillation (which is also the condition for producing pure sine waves), a slight decrease in grid potential will stop the oscillations.

If the negative resistance part of the pliodynatron curve, instead of being straight, is curved like that of figure 4, the oscillations will not fall abruptly from full value to zero when the grid potential is reduced beyond the critical value, but will be gradually reduced in amplitude as the grid potential is decreased. This is exactly what is required for the radiophone and it is easy to make pliodynatrons which have this characteristic.

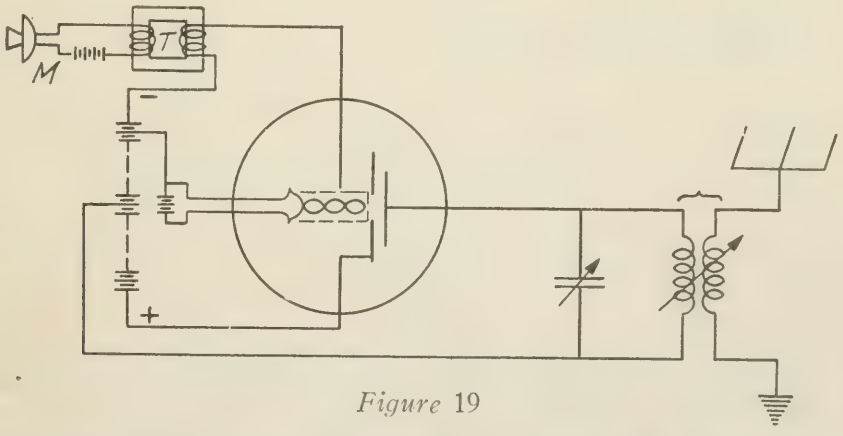


Figure 19

The connections are shown in figure 19. The oscillating circuit is the same as figure 11, except that the dynatron is replaced by a pliodynatron, and is coupled inductively to the antenna. A microphone M, coupled through the transformer T to the grid circuit of the pliodynatron, serves to control the amplitude of the oscillations. A battery of a few volts, between grid and filament, keeps the grid always negative with respect to filament.

It is found that, with a proper ratio of inductance to capacity, the amplitude of the radio waves is very nearly proportional to the grid potential, and hence to the instantaneous displacement in the vocal wave. This was proved for constant grid potential by means of a hot wire ammeter in the antenna circuit, and for alternating grid potentials by impressing a sine wave on the transformer T, and observing the form of the rectified radio waves in a coupled circuit containing a kenotron rectifier and oscillograph.

Under these circumstances, it was found that speech transmitted to the microphone *M* and received at a station a few miles distant suffered very little more distortion than in the ordinary wire telephone. With a small tube giving about 10 watts, it was possible to radiophone 16 miles (26 km.) with good intensity and articulation. No attempt has been made to telephone greater distances, or to develop high power pliodynatrons. The maximum output of a single tube which it has been possible to control thus far is about 60 watts.

11. Magnetically Controlled Dynatron as Radio Telephone

Instead of controlling the negative resistance by a grid, as in the pliodynatron, we may use a magnetic field, as explained in Section (7). It is seen from figure 14 that the change both in slope and amplitude of the negative resistance portion of the curves is a continuous function of the magnetic field strength. Hence if the magnetic field coil is connected in series with a microphone, the amplitude of the radio oscillations may be controlled by the voice, as in the pliodynatron. The energy needed to set up a magnetic field of the required strength is small, and can easily be furnished by the microphone circuit, but the impedance of the coil tends to choke out the higher voice frequencies.

12. Dynatron as Amplifier and Detector

It has been shown in Section 6 that a small periodic electromotive force impressed upon a circuit containing a dynatron may be amplified in any desired ratio by properly adjusting the capacity and inductance of the circuit; that is, the resonant value of current or voltage in the dynatron circuit is infinite, except as it is limited by the length and straightness of the dynatron curve. The impressed oscillations may be radio oscillations in an antenna coupled with the dynatron circuit, and the amplified voltage or current be used to operate a detector. It is important to notice that the energy consumed in the detector does not decrease the amplification, since the dynatron can be adjusted just to neutralize this loss, in addition to the other losses in the oscillating circuit. The simplest examples

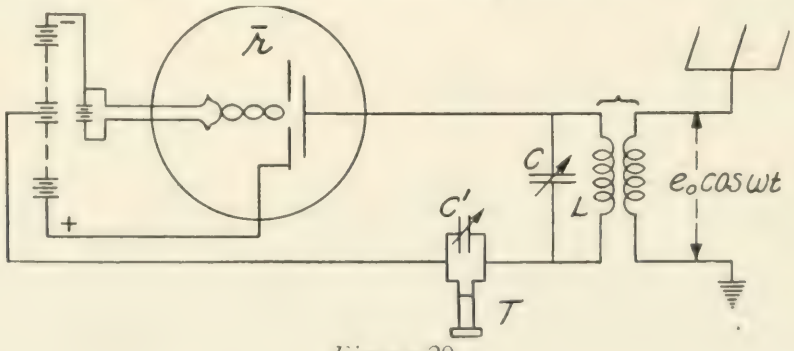


Figure 20

are when the detector losses are of a pure resistance nature, as, for example, when a high resistance galvanometer, such as one of the Einthoven type, is inserted in the oscillating circuit, or an audion with leaky grid, the leakage being proportional to voltage, is connected across any part of the oscillating circuit. In these cases, equation (4) of Section 6 applies directly, the positive resistance *R* being the total resistance of the circuit, including galvanometer and grid. In the cases where the detector is inductively coupled to the oscillating circuit, the impedance due to the coupling is equivalent to a resistance, so that similar relations hold.

Since the amplitude of the "resonant current" in the dynatron circuit is limited by the length and straightness of the negative resistance curve, it is evident that if we operate the dynatron in a region very near one end of the curve, as at *A* or *C*, figure 3, the current will be asymmetric, and the dynatron may itself be used as a detector. Suitable connections are shown in figure 20, where a telephone *T* with condenser *C′* across its terminals is inserted directly in the dynatron circuit. The distributed capacity between turns of the telephone offers low resistance to radio frequencies, so that the conditions of amplification discussed above still hold.

But the high inductance of the telephone will, according to condition (3) of Section 5, cause the circuit to oscillate at audio frequency, unless its resistance be very high, or a condenser C', of suitable capacity, be connected across its terminals.

The circuit shown in figure 20 has two advantages, in addition to its high amplification, viz.:

1. The ratio of inductance to capacity may be adjusted so that the circuit oscillates with natural frequency very near that of the radio waves, as explained in Section 6, thus producing heterodyne beats.

2. The capacity C' and negative resistance $\bar{r}$ may be so adjusted as to neutralize the resistance of the telephone for a particular audio frequency, determined by the product of C' and telephone inductance, and if this frequency be made the same as the group frequency of the incoming radio waves, the sensitiveness becomes very great.

These predictions have been verified separately by experiment. In order to test the behavior of the complete circuit, it was set up as in figure 20, and its reception of signals from a small spark set compared with that of a sensitive audion. For very weak signals the audion was the more sensitive, indicating small asymmetry in the dynatron oscillation. For medium signals, however, the dynatron response was many times stronger, and its intensity could be increased to almost any degree by adjustment of the capacity C'.

It is interesting to note that the coupling in a circuit like that of figure 19 may be made very close without affecting the selectivity, since the condition for selectivity, viz.: a small damping factor, still holds. This is true both for the antenna coupling and that of the auxiliary detecting circuit, when one is used. The fact that sensitiveness and selectivity are independent of both resistance and coupling coefficient makes it possible to use a much more effective ratio of transformation than has hitherto been practicable.

13. Use of Dynatron for Neutralizing Resistance in Radio Circuits

The negative resistance of the dynatron may be utilized to supply the energy losses of whatever nature, in any circuit, and the circuit thereupon behaves, as regards selectivity, damping, and sensitiveness to external stimuli, like a circuit

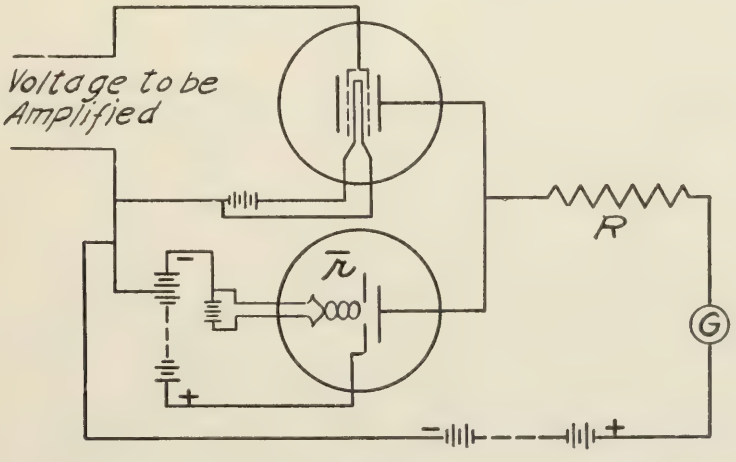


Figure 21

having zero resistance. The amount of energy fed into the circuit by the dynatron is i^2r, where r is the negative resistance and i the current (steady value or r.m.s.) through the dynatron. Examples of this use of the dynatron in simple circuits containing resistance, inductance and capacity have already been given in Sections 3 to 6. Two further examples will illustrate its use in circuits where the resistance characteristic is more complex.

(a) Dynatron in Plate Circuit of Pliotron for Aperiodic Amplification.

The current through the pliotron, for constant grid voltage, increases with increasing voltage of the plate, that is, it has the characteristic of a positive resistance, which limits its amplifying power as explained in Section 8. This resistance characteristic may be neutralized by connecting a dynatron in parallel with the pliotron, as in figure 21. Using a pliotron whose "positive resistance"

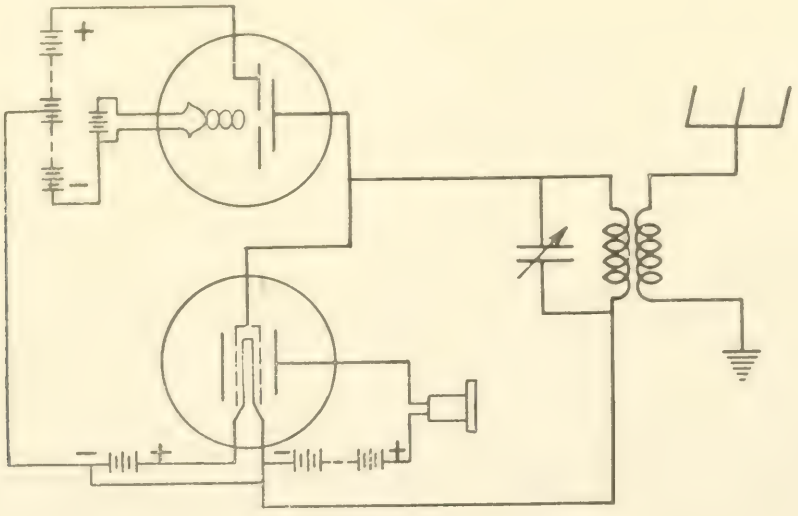


Figure 22

was 100,000 ohms, and a series resistance of 250,000 ohms in the circuit, we were able in this way to increase the d. c. voltage amplification from 12-fold, for the pliotron alone, to 625-fold. A further advantage in this connection is that the dynatron can be operated at such a voltage that its current is just equal and opposite to that of the pliotron, so that the total current through the circuit is zero. This allows the use of a more sensitive measuring instrument.

(b) Dynatron in Grid Circuit of Pliotron Detector.

The increase in voltage of the grid of a pliotron detector is opposed by a leakage current which increases with voltage, as in a positive resistance, and also by the counter e. m. f. and losses in its own and the coupled antenna circuit. These losses may be neutralized by a dynatron in parallel with the grid, as in figure 22. With this arrangement the intensity of weak signals from a spark set was increased from audibility to a roar.

The dynatron, instead of being connected directly to the grid of the pliotron, may be in a separate circuit which is inductively coupled to any part of the grid or antenna circuit.

14. Pliodynatron as Amplifier and Detector

It has been shown in Section 8 that a pliodynatron in series with a suitable resistance is capable of producing an aperiodic voltage amplification of 1000-fold. To maintain this amplification requires constant batteries and continuous attention. A value of 100-fold, is, however, very easy to maintain. By connecting two pliodynatrons in series a total amplification of 10,000-fold has been obtained. With this amplification it should be possible to receive radiograms on an aperiodic antenna.

This arrangement of pliodynatron and positive resistance is equally applicable to a tuned antenna circuit. The connections are shown in figure 23. The telephone itself furnishes sufficient resistance, and a condenser C' connected across the telephone is adjusted so that its capacity is just sufficient to keep the circuit from oscillating, according to condition 3, Section 5. With this connection, the amplification is asymmetric, i. e., different for posi-

tive and negative variation in grid potential, as shown in figure 18. To increase the selectivity, a circuit LC, tuned for radio frequency may be included in series with the telephone, and either adjusted to the verge of oscillation, or allowed to generate oscillations for heterodyne work. The telephone should, in case of radiograms, be tuned for the group frequency of the

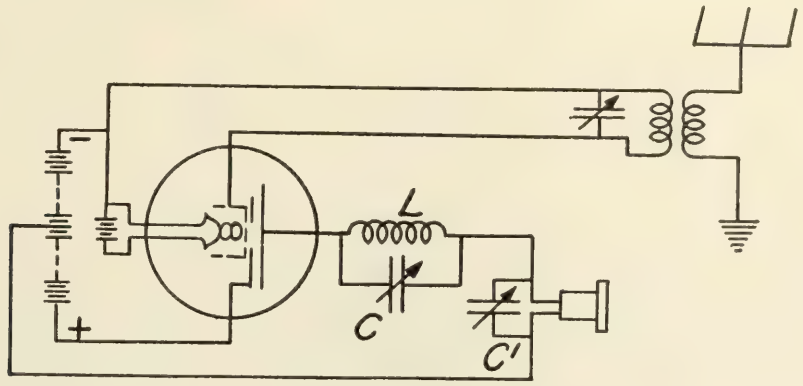


Figure 23

signals. It may then be brought to the verge of audio-oscillation by adjusting the negative resistance, and the final adjustment for radio sensitiveness be made by varying the ratio of L to C, keeping their product constant.

In the circuit of figure 23 all the losses may be compensated, in the manner just described, except those in the grid circuit and antenna. Figure 24 shows a modification of the circuit of figure 23 in which the grid and antenna losses also are compensated. The modification consists in connecting the grid, not to the filament, but to a properly chosen point P on a resistance R in series with the plate. The pliodynatron is then operated at such voltage

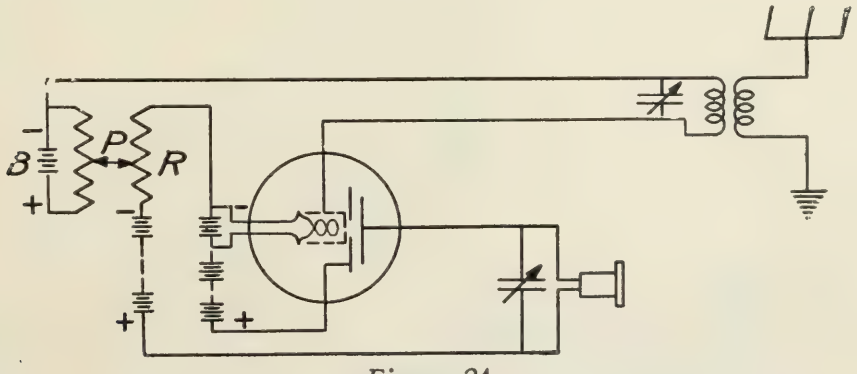


Figure 24

that the current in the plate circuit is negative (between B and C, figure 3), that is, positive electricity, or its equivalent, flows from filament to plate across the vacuum and thence through the battery and resistance R back to filament. Raising the potential of the grid increases the current through R, and raises the potential of P, which tends still further to increase the potential of the grid. By this mechanism, energy is fed back from the plate circuit, which may be adjusted to furnish any amount of energy desired, into the grid circuit, and by properly adjusting P, the amount of energy thus appropriated may be made just sufficient to neutralize the losses in grid and antenna, without causing oscillation. The antenna coupling should be close, and its resistance may be as large as desired. A potentiometer is shown connected across a battery B the voltage of which is equal to the normal drop in R, for keeping the grid potential constant during adjustment.

(C) Press Ill. Svce.

The generally known need of the German army for rubber appears to accent the reverse conditions in England, where rubber is sufficiently plentiful to permit mounting this small gun on automobile wheels

Experimenters' World

FIRST PRIZE, TEN DOLLARS

A Receiving Set for a Wide Range of Wave Lengths

THE receiving set described herewith was designed to give a wide range of wave length with the least possible number of switches, and to afford the greatest convenience in tuning to a given station.

The general appearance of the front of the cabinet is shown in figure 1, a rear view wiring diagram in figure 2, and constructional details appear in figure 4. The connections for the vacuum tubes are shown in figure 5, and for the crystal rectifier in figure 6.

The cabinet is made of mahogany one-half inch thick; the base should be three-quarters of an inch in thickness. The front panels are four inches wide and eighteen inches long, held in place by brackets 6 and 7 of figure 4,—6 for the top panel "B" and 7 for the lower panel "A." The brackets for panel "A" are fastened by three-sixteenths of an inch 6-32 round head screws on the inside of the panels, which hook over a round head wood screw in the side and bottom of the cabinet. Since panel "B" is movable, and has a contact spring for throwing the mineral detector in circuit, all four brackets are constructed so that the panel can be pushed straight in. The wood screws on the inside of the cabinet are then taken up to hold it in place.

In the lower left hand corner of panel "A" is a push-button for the buzzer tester. I may mention, however, that one can secure the same results by throwing the variable condenser in series with the aerial and then placing it on short circuit. The discharge of the condenser produces a characteristic click which enables one to find the best adjustment of the oscillation detector.

The variable condenser of the primary circuit is connected in series with the aerial and when thrown one point beyond full capacity is placed on short circuit. This does away with the use of a single pole switch.

The tuning transformer is built along the lines of the famous "Blitzen" except that I have arranged it so that the primary and secondary switches require but a half turn. The reader must keep in mind that this set was built some time ago, and of course, I have added many improvements. In building another set of this kind, I would design the tuner like a Blitzen except that I would have the switch contacts on the front after the present design, using the larger circle of contacts for groups of "tens" and the smaller for single turns. The Blitzen permits sharper tuning than my design.

In respect to the secondary, the reader will note that it is tapped and connections are brought out to the front of the panel in the same manner as with the primary coil. The terminals of the secondary taps are connected to small screws in the side of the hard rubber ring. Connection is made through a flexible 15 conductor silk covered cable. As the secondary can only make a quarter turn this cable never gets caught or twisted and does not put undue strain on the connections. (Note particularly the diagrams figs. 2, 5, and 6.)

The secondary condenser is connected across the secondary inductance as usual but is not generally used with the valve. It is found very useful, however, when the mineral detector is employed. These two variable condensers were bought disassembled from the Clapp Eastham Company.

The switch for connecting in the loading coils also connects both the primary and secondary simultaneously in rather broad steps. Adjustments between the coils are made by changing the coupling of the tuner, which with a normal aerial will respond to a little over a thousand meters.

The coupling between the primary and secondary at the loading coils is varied by a small handle and brass rod running through the center of the switch handle (figure 1) to the rear of

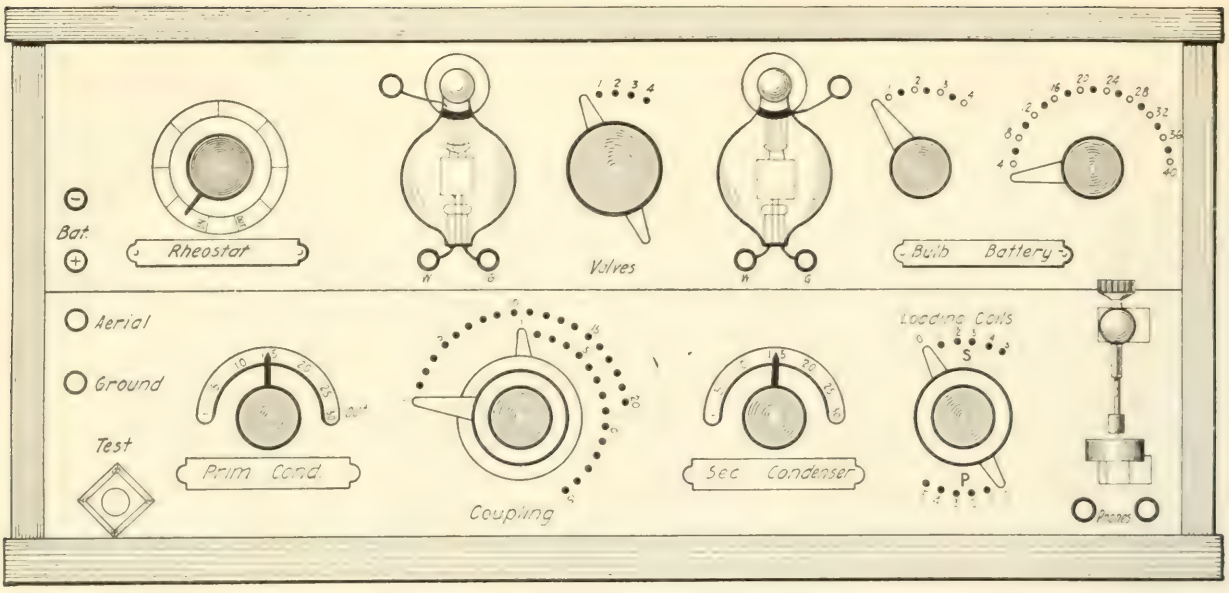


Figure 1—Front view of Cabinet

the set, where a cam made of a piece of one-sixteenth inch brass controls the primary. I am fully aware that a loading coil and a tuner wound doughnut fashion such as used in this set are condemned as inefficient, but I can truthfully state that by using the mineral detector (not the valve) I have heard South Wellfleet, using the spring of a couch bed for an aerial and the steam radiator for a ground! My station is on the second floor of an ordinary frame dwelling and about sixty miles from the station.

The mineral detector shown to the right of figure 1 is the universal type, first used by the Marconi Company. At the left of the panel, figure 1, will

FISCHER SWEENY BRONZE COMPANY
SERVICE CASTINGS QUALITY

Quick Service
Fine Quality

Bronze and Aluminum Castings of the Better Grade

Our facilities enable us to make prompt shipments of quality castings in large quantities at attractive prices.

Castings guaranteed true to pattern.

Let us quote on your requirements.

Bronze Rods and Bushing Castings

Fischer-Sweeny Bronze Company
HOBOKEN, NEW JERSEY

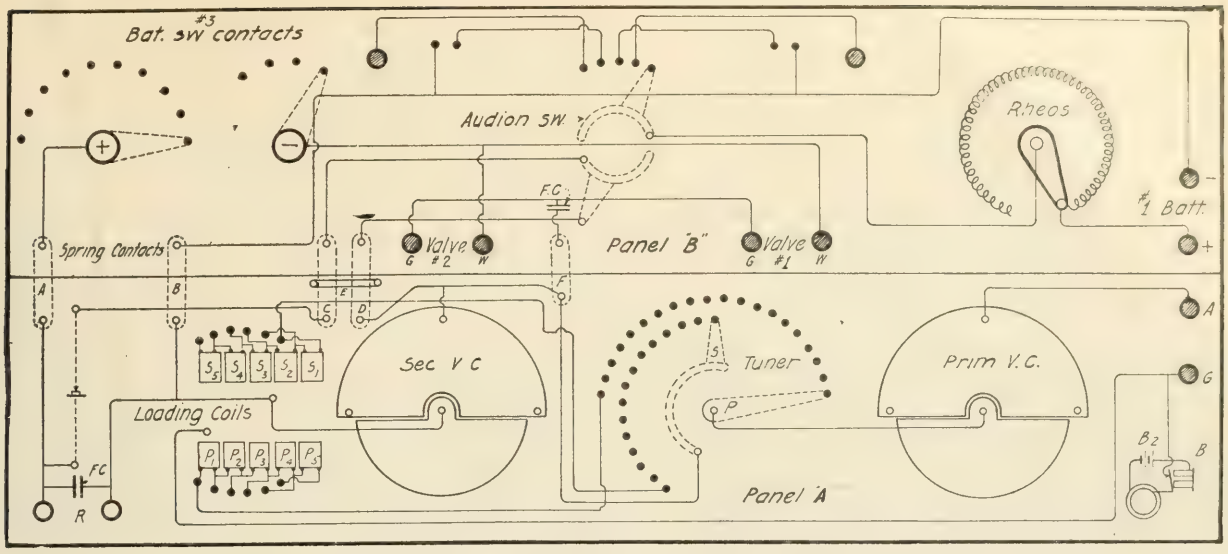


Figure 2—A rear view wiring diagram

be seen the hard rubber binding posts for the aerial and ground connections, and on the right in the lower corner are the posts for the head telephones.

Connections between panels "A" and "B," figure 2, are made with five one-thirty-second inch phosphor bronze springs A, B, C, D, and F. Removing panel "B" allows contact springs C and D to come toward the front of the set making contact with cross piece E and closing the detector circuit.

Since the batteries are mounted on a shelf in the back of the cabinet, in a box, panel "B" can be removed from the set by loosening four screws in brackets number 6 (figure 4) on the inside of the cabinet. It can then be pulled straight out.

The switch for the filaments of the

LICENSE PREPARATION FOR MASTERS, MATES AND PILOTS

WARRANT OFFICERS, PETTY OFFICERS AND SEAMEN IN THE U. S. NAVY PREPARED FOR THEIR EXAMINATIONS

Uttmark's Nautical Academy

PRACTICAL NAVIGATION FOR YACHT-OWNERS AND OFFICERS OF THE PATROL SQUADRON AND NAVAL MILITIA. COMPASSES ADJUSTED

FORMERLY PATTERSON'S NAVIGATION SCHOOL
ESTABLISHED 1882

8 STATE STREET, NEW YORK
FACING BATTERY PARK

CAPTAIN FRITZ E. UTTMARK
PRINCIPAL.
PROFESSOR IN NAVIGATION AND NAUTICAL ASTRONOMY

Facing South and overlooking the Bay, in a quiet place, the building offers for students the very best facilities for studying. Observations of the heavenly bodies will be taken from the bridge on the roof, which is being equipped with compasses, pelorus, and other instruments, and practical use of same will be demonstrated, also practical sextant work will be done and position found by observations taken from the bridge.

This academy has the reputation of being the oldest and best equipped navigation school in the United States and is up-to-date in every respect. All our instructors are experienced teachers and able to up-hold the excellent reputation which the school has attained by many years of efficient work.

The new school building is most conveniently situated at No. 8 State Street, *opposite the Barge Office at Battery Park. It is within two minutes' walk* of Bowling Green and South Ferry subway stations, all the elevated trains, South Ferry, Staten Island Ferry and Atlantic Avenue Ferry. *The Custom House,* where the Board of Local Inspectors holds the examinations for masters, mates and pilots *is just around the corner.* In other words this school forms the hub or center of everything connected with shipping and shipping interest.

You and your friends are cordially invited to visit the school and inspect the new equipment. You will receive a hearty welcome. Please tell your friends about it.

All You Want to Know About Signal Corps Work Is in This Volume

Military Signal Corps Manual

By Major J. Andrew White

Chief Signal Officer of the American Guard, Member Institute of Radio Engineers, Acting President Nat'l Wireless Association

This manual, the first of its kind and the only complete work on the broad subject of army signaling, is indispensable to those responding to the call to the colors. Primarily prepared for Signal Corps men, it is a necessity for the proper understanding of apparatus and the tactical employment of troops and equipment.

Officers of infantry and artillery will find the volume of great utility, a proper conception of the enormously enlarged Service of Information being indispensable to all commissioned men.

Prepared with the full co-operation and approval of the Chief Signal Officer, U. S. Army.

CONTENTS

Part I.—Organization

The Signal Corps, An Auxiliary Branch of the Army. The Signal Corps' Relation to the Line of the Army. Aircraft. Government and Administration. Military Courtesy. Personnel. Proficiency Test for Companies of Signal Troops.

Part II.—Drill Instruction

General Principles. Definitions. Commands and Signals. School of the Soldier. Physical Training. School of the Squad. Instruction with Arms. The Company Dismounted. The Soldier Mounted. Elementary Collective Instruction Mounted. Field Signal Troops. The Wire Company. The Radio Company. The Outpost Company. The Field Battalion. Telegraph Signal Troops. The Telegraph Company. The Telegraph Battalion. Base Line Signal Troops. Depot Signal Troops. Ceremonies. Reviews. Inspections. Funeral Escort. The Standard. The Guidon. Manual of the Saber.

Part III.—Technical Instruction and Apparatus

Telegraphy and Telephony. The Voltaic Cell, Ohm's Law, and Primary and Secondary Batteries. The Camp Telephone and the Buzzer. Induction Telegraph Set. Radio-telegraphy. Radio Apparatus of the Signal Corps. Visual Signaling Equipment. Flag Kits. The Heliograph. The Acetylene Lantern. Technical Equipment of Personnel.

Part IV.—Transmission

Transmission of Military Information. General Instructions for Army Signaling. The American Morse Code. The International Morse or General Service Code. Instruction in Garrison. Visual Stations. Telegraphy. Visual Signaling in General. Signaling by Flag, Torch and Lantern, or Beam or Searchlight (without Shutter). Signaling with Heliograph, Flash Lantern, or Searchlight, (with Shutter). The Ardois System. Signaling by Two-Arm Semaphore. Signaling by Hand Flags. General Instructions for Locating and Operating Visual Stations. Letter Codes. Telegraph Code Books and Ciphers. Conventional and Preconcerted Signals with Rockets, Bombs, Small Arms and Guns. Flag Signals by Permanent Hoist. Emergency Signals. Conventional Telephone Signals.

Part V.—Field Service

Signal Troops in the Field. Reconnaissance, Patrolling and Scouting. Military Map Reading. Signal Troops in Field Service. Field Lines. Camps. Company Guard Mounting. The Signal Corps and General Coast Defense. Coast Defense Information in War.

Cloth. 588 pages. 260 illustrations.
Price $1.50 net.
Add 15c postage to above price

WIRELESS PRESS, INC.
25 ELM STREET NEW YORK, N. Y.

two vacuum bulbs is built with a second blade or contact which automatically throws the mineral detector out when the valves are thrown in, thereby making unnecessary the use of a double throw switch.

I have always found the ordinary switch for varying the battery current objectionable in that if the points were

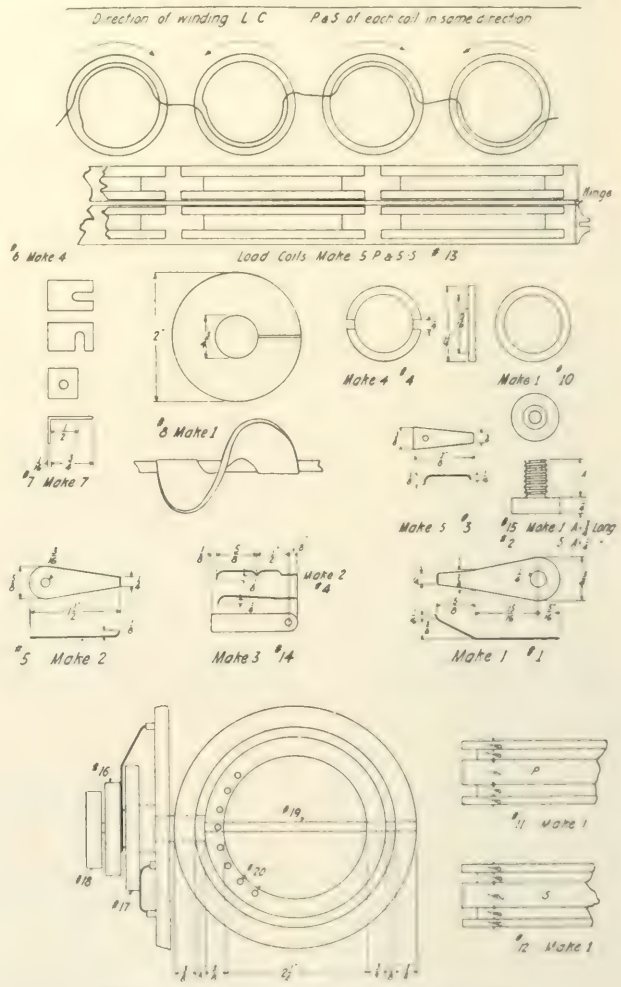


Figure 4—Constructional details

near enough together to keep the blade or contact from sticking between them they would short circuit the set of batteries between these two particular points, and if the points were a greater distance apart than the width of the contact blade, the spring in the contact would force it down and it would hit or catch against the side of the next contact even though both the contact points and the contact spring were "rounded off."

For the above reason I use a dead point between each two live points making the width of the sliding contact a little less than the total distance between the live contacts.

The loading coils are wound on ten

separate hard rubber discs three-and-a-half inches in diameter. They are mounted five to a set, flat on the rear. Five coils are part of the secondary circuit and the other five are for the primaries. They are mounted on a thin piece of fibre sheet, hinged, and mounted face to face with the five secondaries. The first coil is wound clockwise, and the second counter clockwise.

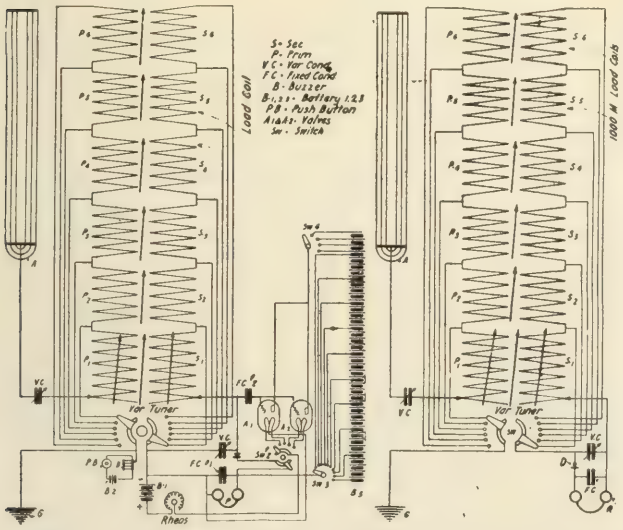


Figure 5—Connections for vacuum tubes

Figure 6—Crystal rectifier circuit

All spring contacts are made of phosphor bronze about one-thirty-second of an inch in thickness.

The contact points are three-sixteenths of an inch in diameter and three-sixteenths of an inch in height. All metal parts are silver plated. The binding posts are made from a six-thirty-second screw one-half inch long, a hexagon nut tapped to fit it, and a small rubber handle with a six-thirty-second tapped bushing made into it.

For the front panels I use one-quarter inch Bakelite and for all handles one-quarter inch hard rubber except the handles on the rheostat, and battery switches which are standard knurled handles about one and one-quarter inch in diameter.

To connect the rod No. 19 (figure 4) to the hard rubber handle it is necessary to put a pin through the handle and rod, also through the rod and secondary coil. The bushing No. 15 is threaded and the primary tapped to fit. The hole through the panel has three-eighths inch clearance, and

At Last—a Practical Book for Aviators

Practical Aviation for Military Airmen

A complete text for intensive study. It provides all fundamental information required to prepare an aviator for actual flying.

By

Major J. Andrew White

Author of "Military Signal Corps Manual." Chief Signal Officer, American Guard.

Each component part of the airplane is shown by diagram and principles and methods of operation are concisely stated in detail therewith.
It treats broadly many subjects not covered in general aeronautic text books.

Contents

Principles of flight; construction of the airplane; rigging; directions for first flights, cross-country and night flying; construction, operation and care of engines; reconnaissance, map reading, signaling and co-operation with military bodies; radio and its uses; machine gunnery and bombing from airplanes, etc.

Cloth, Price $1.50

Postage 15 cents

Ready About September First

Wireless Press, Inc.

25 Elm Street **New York City**

Are You a Radio Instructor?

You Will Find This Book Very Valuable

Every instructor and teacher of radio, whether teaching in college or Government training school will find

RADIO INSTRUMENTS AND MEASUREMENTS

Prepared by the
Bureau of Standards
Washington, D. C.

a valuable reference book for every day use.

Contents

Part I. Theoretical basis of radio measurements. The fundamentals of electromagnetism. The principles of alternating currents. Radio circuits. Damping.
Part II. Instruments and methods of radio measurement. Wave meters. Condensers. Coils. Current measurement. Resistance measurement. Sources of high-frequency current.
Part III. Formulas and Data. Calculation of capacity. Calculation of inductance. Design of inductance coils. High-frequency resistance. Miscellaneous formulas and data.

In Press, Ready About August 10
Full cloth binding, 320 pp. Price $1.25.

Wireless Press, Inc.

25 Elm Street **New York City**

EQUIP YOURSELF WITH A RELIABLE BUZZER SET

Here Is a Set That Will Give You Excellent Results

The main object of this Practice Set is to enable the beginner to learn the Continental Code, which is easily mastered as the buzzer reproduces the sound of the signals of the most modern wireless stations perfectly.

It comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base; three nickel plated binding posts are also mounted on the base and so connected that the set may be used for individual code practice or for operation of a two party line, an excellent method of quickly learning the code. After the beginner has mastered the code, the set may be used in his wireless outfit for setting the detector in adjustment, and also the key may be used to control the spark coil.

Recommended for private use and for schools, as it gives excellent service for class instruction in code work. Full directions with each set.

When used in connection with Marconi-Victor Records this set enables the student to make exceedingly rapid progress.

Wireless Practice Set, with Red Seal Dry Battery and cord.....$2.70

WIRELESS PRESS, Inc.

25 ELM STREET NEW YORK CITY

therefore the bushing holds the primary coil against the panel. This bushing has a one-quarter inch hole through it which is large enough to carry the tube connected to the primary handle. This tube is scratched on the end to make it rough and it is driven into the primary handle. The contact spring has a one-quarter inch hole and it is soldered on to the tube which extends an eighth of an inch beyond the face of the handle. This keeps the coupling handle far enough away to be easily manipulated.

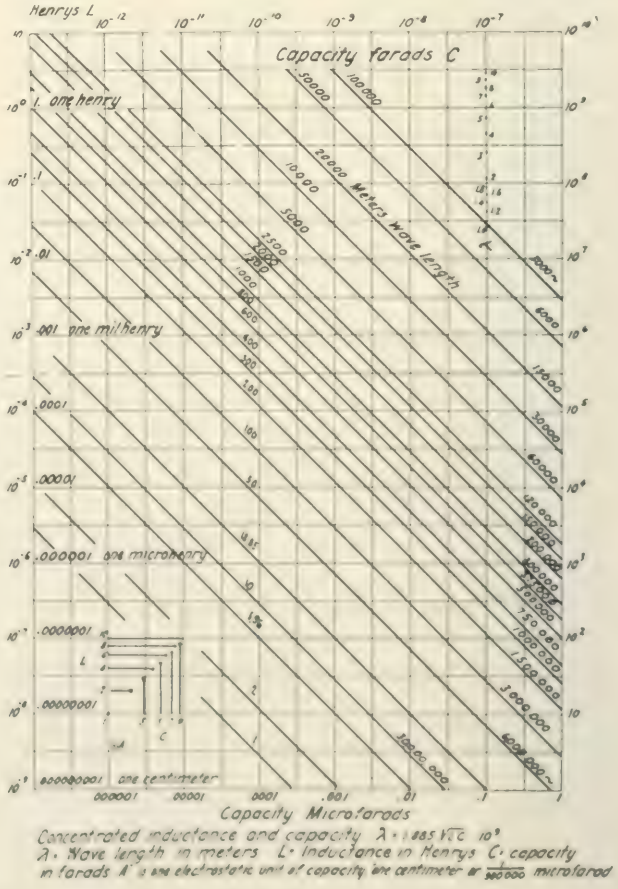
The ring No. 8 is cut from one-sixteenth inch copper or brass and then cut to the center hole and pulled as shown in the drawing. This is soldered on to the one-quarter inch coupling rod.

F. CLIFFORD ESTEY, *Massachusetts.*

SECOND PRIZE, FIVE DOLLARS

Convenient Chart in Making Wireless Calculations

FOR the benefit of your readers I am sending you a chart (figure 2) which I have found convenient in wireless calculations. It shows the relation between concentrated capacity


Henrys L
Capacity farads C
L one henry
one millihenry
one microhenry
one centimeter
Capacity Microfarads
Concentrated inductance and capacity λ = 1885 √LC 10⁹
λ = Wave length in meters L = Inductance in Henrys C = capacity in farads

and inductance, and the frequency of a circuit, and also the relation between the c. g. s. units and the practical units. It could be re-drawn on a larger scale with logarithmic subdivisions and reduced photography. Please note that taking the first space of 10 centimeters for inductance as one inch, which it is, the diagram is 16,000 miles in length!

I should like to add finally, that of all of the publications that I have ever read there is none equal to The Wireless Age.

E. M. Tingley, *New Jersey.*

THIRD PRIZE, THREE DOLLARS

An Inductively Coupled Receiving Transformer

A RECEIVING transformer does not necessarily require variable coupling. I have found that for the average work the primary and secondary coils may remain in a fixed relative position provided the construction is carried out as per the accompanying sketch, figure 1. The design shown does not possess any advantage in efficiency over the ordinary coupler, but it is easier to construct.

The principal part of the apparatus is an old-fashioned tuning coil. The windings are removed from one end for about two or three inches and ten or fifteen taps taken from the remainder.

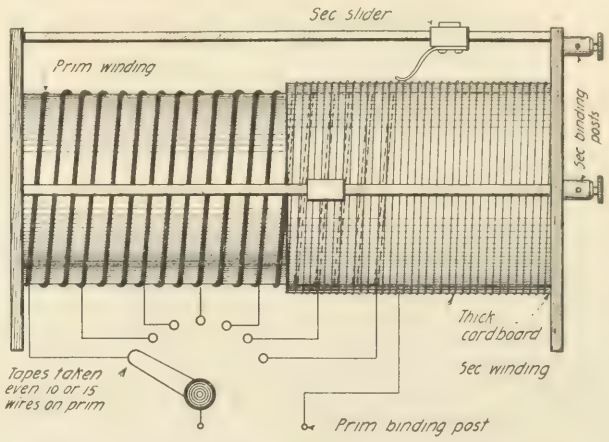


Figure 1—Diagram showing construction of inductively coupled receiving transformer

A piece of card-board is cut just to fit over the bare end of the coil. It should be about two-and-a-half inches in length. A coil is wound over this.

An ordinary piece of stiff card-board can be made pliable and fitted without cracking, by wetting it and then gluing it around the coil when dry. A layer

Red Seal Dry Batteries Are Guaranteed

to give absolute satisfaction for Automobiles, Motor Boats, Gas or Gasoline Engine Ignition, Medical Batteries, Telephone, Door Bells, Annunciators, Wireless Apparatus or any other open circuit work.

ASK YOUR DEALER

Send for Our New Edition of Our Catalog N28 Now on the Press—Ready for Distribution At An Early Date

It will be pocket size, 8x4½ and will contain 248 pages with over 1,100 illustrations, describing in plain, clear language all about Bells, Push Buttons, Batteries, Telephone and Telegraph Material, Electric Toys, Burglar and Fire Alarm Contrivances, Electric Call Bells, Electric Alarm Clocks, Medical Batteries, Motor Boat Horns, Electrically Heated Apparatus, Battery Connectors, Switches, Battery Gauges, Wireless Telegraph Instruments, Ignition Supplies, etc. ***SEND FOR A COPY NOW***

MANHATTAN ELECTRICAL SUPPLY COMPANY, Inc.

NEW YORK, 17 Park Place CHICAGO, 114 S. Wells St. ST. LOUIS, 1106 Pine St. SAN FRANCISCO, 604 Mission St.

THE WORK WE DO

Publications House Organs
Multi-color Printing
Catalogues Street Car Signs
Direct Mail Pieces
such as
Booklets, Folders, Mailing Cards Etc..
Advertising Composition Commercial Stationery
Office and Factory Forms

THE CUSTOMERS WE SERVE

International Magazine Hearst's Magazine
Good Housekeeping Magazine
Cosmopolitan Magazine Harper's Bazar
International Film Service Inc.
Wireless Press Towse Publishing Co
American Weekly Magazine
B'way Subways & Home Boroughs Car Ad. Co.
Humanitarian Publishing Co.

THE McCONNELL PRINTING COMPANY

226-242 WILLIAM ST. E. E. WONDERLY Manager Phones: Beekman 2980, 81, 82 NEW YORK CITY

·WRITE OR PHONE OUR SERVICE DEPARTMENT·

YOUR Opportunity to Secure a Practical Home Study Course in Wireless

THE Marconi Institute Extension Training Course and Service is a systematic, time-saving means of furnishing to students in the war camps, homes or local radio clubs, orderly and scientific training through literature prepared by the leading exponents of the art.

It is indispensable to experimenters or students who desire a thorough working knowledge of *wireless.* This service already has been subscribed to by 8,000 men.

It is planned primarily for those who are progressive and alert and who look ahead to the future.

Wonderful expansion in every department of scientific development and industrial application is assured. Students and experimenters who use the opportunities presented to them through the Institute Extension Course and Service, will never regret the time given to such study.

It is not essential that students have a college or technical education, but one thing is necessary: they must have a serious purpose and be willing to devote a reasonable portion of their spare time to study and practice.

The Institute Training Service for Schools and individuals comprises the following publications:

Wireless Age, yearly subscription	$2.00
Practical Wireless Telegraphy	1.50
How to Pass U. S. Government Wireless License Examination	.50
Radio Telephony	2.00
Military Signal Corps Manual	1.50
Victor Records for Code Practice (12 *lessons*)	6.00
Key, Buzzer and Red Seal Battery	2.70

These items may be ordered *separately,* as required, or *in combination* at a discount of 10 per cent. on the magazine and text books, but not on the Records and Apparatus.

Extension Service Department

MARCONI INSTITUTE

25 Elm St. - - New York City

Local and County Representatives Wanted

to present this course to wireless amateurs and others looking forward to enlistment in the Signal Corps or Naval Radio service. Liberal terms.

of wire similar to that wound on the secondary of a receiving transformer, say No. 28 or No. 32, is wound over the card-board. The coil is scraped in two places and sliders attached for variation of the inductance. The two original sliders of the tuning coil can probably be arranged to pass over the bare surfaces. The secondary coil is wound partly over the primary coil and partly over the bare end. It is to be observed, however, that the secondary is outside the primary and not inside as in the usual design.

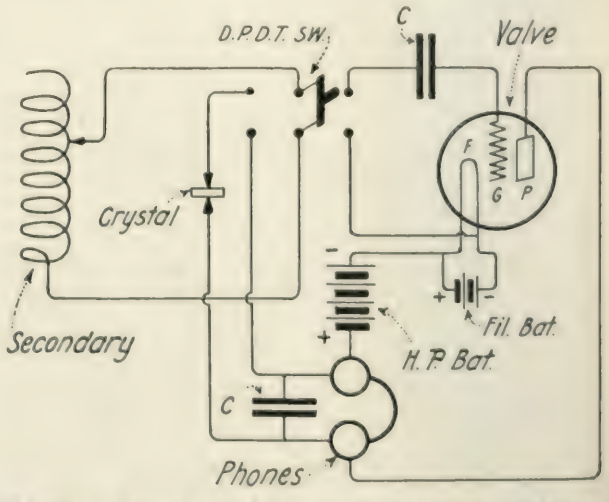
The operation of this tuner is comparatively simple. The number of secondary turns in use can be varied by the position of the sliders, and the degree of coupling in the same way. For example, if in the secondary fifteen turns are required for resonance, these turns can be taken at either end of the coil, and the coupling between it and the primary correspondingly changed. For close coupling both sliders are moved along the secondary coil until they are directly over part of the turns of the primary winding.

No definite dimensions are given for the coil as they would naturally vary with the wave length range required. A tuner of this kind will be found to give very satisfactory results.

D. B. LOVIS, *Massachusetts.*

Changing from the Vacuum Tube to the Crystal Detector

I HAVE found a double pole double throw switch of great advantage in changing from a crystal detector to a



Circuit for changing from vacuum tube to crystal detector

vacuum valve. I used a circuit like this quite successfully before the War.

One of the important considerations in my circuit is the use of a condenser across the telephones while employing the valve. This I find to be a benefit and not a detriment. In using either oscillation detector, parts of the other detector circuit remain attached to the circuit in use, but my experience indicates that this does not affect the signals. I trust that the accompanying diagram will be of interest to the readers of the WIRELESS AGE.

S. F. MCCARTNEY, *Pennsylvania.*

A Multi-layered Tuning Coil

THE multi-layered tuning coil herewith described proves very efficient in receiving undamped waves. It can only be used with a vacuum tube. Good receiving ranges have been obtained with two of these coils ten inches apart. They are wound on a form five inches in diameter and twelve inches long, with grooves one-half inch deep, one-quarter inch wide and one-half inch apart, cut in as shown in figure 1. The ends are made of wood six inches by six inches by three-quarters of an inch. On one of the ends is mounted

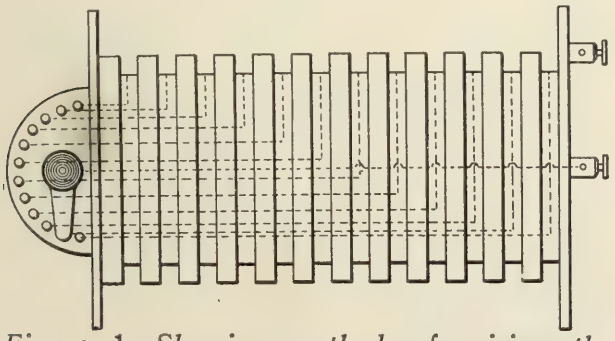


Figure 1—Showing method of wiring the multi-layered tuning coil

a switch base in the form of a semicircle. It has twelve contact points.

Seventy-five turns of No. 32 B. & S. wire are placed in each groove. The terminal of each coil is attached to a switch point and soldered on to it. One wire is brought from the switch lever to a binding post and the beginning of the coil is attached to another binding post. The coil should make a valuable addition to any wireless set after the War.

CHARLES WILDONGER, *New Jersey.*

Serve Your Country

To help meet the demand for trained men for the National Service and to replace those called from the ranks of mercantile life we now provide in the pages of

THE WIRELESS AGE

practical training courses in the following branches, of which there is urgent need

AVIATION

Conducted by Henry Woodhouse, Governor of the Aero Club of America

SIGNAL CORPS WORK

Conducted by Major J. Andrew White, Chief Signal Officer, American Guard

WIRELESS TELEGRAPHY

Conducted by Elmer E. Bucher, Director of Instruction, Marconi Institute

NAVIGATION

Conducted by Capt. F. E. Uttmark, Principal Uttmark's Nautical Academy

The cost of similar instruction in regular training schools would be—

Aviation	$75
Signal Corps Work	75
Wireless Telegraphy	65
Navigation	100
Total	$315

Offered in THE WIRELESS AGE for $2.00

Special Club Rates for Classes, Associations and Societies

Wireless Press, Inc. 25 Elm Street New York

Do You Read the Wireless World?

In it you will find articles relating to the PRACTICE of Radiotelegraphy as well as to the THEORY.

The QUESTIONS and ANSWERS SECTION is open to YOU for the SOLUTION OF YOUR DIFFICULTIES.

INSTRUCTIONAL ARTICLES for Home Study WRITTEN BY EXPERTS.

REVIEWS OF BOOKS useful to Wireless Students. The interests of Operators are well catered for.

WRITE for a Specimen Copy, post free to

THE WIRELESS PRESS, Ltd.

Marconi House, Strand, London, England

"WIRELESS WORLD," $2.25 per annum for America. Single Copies, 25c Post Paid

Every Radio-Man Will Be Interested in This New Book

Can you adjust a Regenerative Beat Receiver to its maximum degree of Amplification?

Do you understand the circuits of a Cascade Radio or Audio Frequency Amplifier?

Do you understand the difference between the adjustments of the Vacuum Tube as a Detector or as an Amplifier?

These questions and all others pertaining to Oscillation Valves are answered in

Vacuum Tubes In Wireless Communication

By ELMER E. BUCHER
Director of Instruction, Marconi Institute, New York

An elementary text book for students and operators.

Tells in understandable language the fundamental operating principle of the vacuum tube.

Shows over 100 different circuits for its practical use as a Detector, Radio or Audio Frequency Amplifier, Regenerative Receiver, Beat Receiver, and Generator of Radio Frequency Currents.

More than 100 diagrams reveal, step by step, in simple and direct form, every possible use of the vacuum tube.

The only text book on the market devoted solely to the various applications of the Oscillation Valve.

Part I—The Oscillation Valve
Part II—Practical Applications of the Valve
Part III—Cascade Amplification by the Vacuum Valve
Part IV—The Regenerative Vacuum Valve Amplifier
Part V—Combined Regenerative and Cascade Amplification Systems
Part VI—The Vacuum Valve as a Detector of Continuous Waves—Audio Frequency Tuning Circuits—Special Circuits for the Vacuum Tube
Part VII—Wireless Telephony
Part VIII—The Dynatron Detector and Oscillator

Every important circuit that has so far been used in connection with the vacuum tube is given. A series of graphic charts in the Appendix reviews the functioning of the vacuum tube in a most elementary manner. The technical introduction reviews the general problems of the continuous and discontinuous transmitters and receivers.

Ready August 1st.
Postage 12 cents extra.
Cloth, Octavo. PRICE, $1.50, net

WIRELESS PRESS, INC.,
25 ELM STREET, NEW YORK CITY

A Novel Method for Changing Degrees Fahrenheit to Degrees Centigrade or Vice Versa

SOME time or other the average person is confronted with the problem of changing the temperature scale from one system to the other. The writer presents a new method which he believes will be welcomed, for by its use one is enabled to change quite easily and accurately, values from one scale to the other.

To change from C° to F° formula (1) is applicable:

$$(1)\quad F^\circ = \left[(C^\circ + 40^\circ)\ \frac{9}{5} - 40^\circ \right]$$

For changing from F° to C° formula (2) is presented:

$$(2)\quad C^\circ = \left[(F^\circ + 40^\circ)\ \frac{5}{9} - 40^\circ \right]$$

Thus, we should always add 40° and then multiply by a factor which depends upon whether we desire to change F° to C° $\frac{(5)}{9}$ or C° to F° $\frac{(9)}{5}$. Then we subtract 40°. Whether or not we should multiply by $\frac{5}{9}$ can easily be seen if we always assume that F° are greater than C°. Then, to change C° to F° we use the larger factor, etc.

Two examples follow:

(a) Change 100° C to F°

$$F^\circ = \left[(100 + 40)\ \frac{9}{5} - 40 \right]$$

$$F^\circ = 252^\circ - 40 = 212^\circ\ F$$

This we know to be true. Hence it acts as a check to the method.

(b) Change 32° F to C°

$$C^\circ = \left[(32^\circ + 40)\ \frac{5}{9} - 40 \right]$$

$$C^\circ = 40 - 40 = 0^\circ\ C.$$

This method is logically accurate, for if we examine these simple equations we will find that —40° C = —40° F.

To sum up, the formula amounts to this: add 40, multiply by 5/9 (F° to C°) or 9/5 (C° to F°) and then subtract 40, which gives the required answer in all cases, above or below zero.

E. DUSKIS, *New York.*

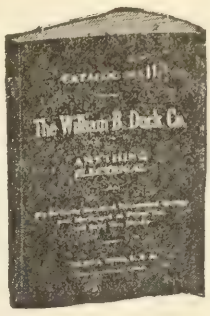
A Novel Electric Inspection Lamp and Magnet

THE accompanying illustrations, figures 1 and 2, show an electric inspection lamp and magnet manufactured at Boston, Mass. It is 18″ in length and 1″ in diameter. The magnet is arranged so that the lamp can be used separately when so desired. The lamp is useful for examining cylinders of automobiles, machinery and ammunition inspection. It is equipped with a 6 volt 4 c. p. power bulb for lighting, and a magnet for picking up small metal parts which cannot be reached by hand. The photograph, figure 2, shows a unique automatic inspection lamp for physicians and dentists which can be carried in the vest-pocket. It is found to be of great value in medical services for examining the mouth and throat.

Figure 1—Electric inspection lamp and magnet

Figure 2—Vest pocket inspection lamp used by physicians and dentists

DUCK'S



BIG 300 pp. ELECTRICAL and WIRELESS CATALOG

Mailed upon receipt of 8c. in stamps or coin which may be deducted on first dollar purchase, Catalog contains 160 pages of wireless instruments and 140 pages of electrical supplies. No bigger or better values are obtainable elsewhere We have a complete stock of everything listed in this catalog. Wireless orders promptly filled.

THE WILLIAM B. DUCK CO.
239-241 Superior St. TOLEDO, OHIO

TELEGRAPHY and RADIO FOR MEN IN DRAFT

Send for our latest folder on LAND WIRE Telegraphy. Day and Evening classes. Prepares for all branches. Particularly attractive work.
DAY and EVENING classes in RADIO for Naval Reserve, Aviation, Signal Corps and Merchant Marine. Beginners every Monday. Send for prospectus.

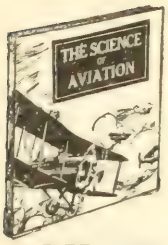
Eastern Radio Institute
899C Boylston St., Boston, Mass.

MEN WOMEN
GOVERNMENT REQUIRES RADIO OPERATORS
Special concentrated courses by experienced teachers for both men and women

MACHINE GUNS
It will mean something to you to prepare yourself for Service. We have a completely equipped school for "setting up" instruction directed by experts in this line.
Write for booklet. *You can begin at any time.*
Y. M. C. A. Radio School
145 E. 86th Street New York, N. Y.
BEST RADIO SCHOOL IN NEW YORK

$37.50 Profit for 3 Days Work
At one of the War Camps between June 4th and 7th one of our men earned $37.50 selling SIGNAL CORPS MANUALS. We need more men like him. Our books are what the Army and Navy men want and need to help them improve their rating. Write for particulars
WIRELESS PRESS, Inc. 25 Elm St., New York City

Military Books For Ambitious Men in Army and Navy
Tell us what books you need and we will gladly recommend the best books on each subject. We study the needs of Army and Navy men and supply only the most helpful text books. Let us know your needs.
WIRELESS PRESS, Inc. 25 Elm St., New York City



LEARN
AVIATION
SEND FOR THIS
FREE BOOK!

OPPORTUNITY is *hammering* at your door. The world is calling for millions of men, trained in the science of Aviation, Designers, Builders, Assemblers, Repairmen, Instructors, as well as "Flyers," and offering to pay them big wages! The first step is to send for our BIG FREE BOOK, THE SCIENCE OF AVIATION. It tells how you can learn the basic principles, the "ground work" of this great profession at home under our corpsof eminent instructors, among them, Walter L. Brock, winner of the Great London-Paris Race, and others equally famous in aeronautics. The course is prepared so the layman can easily master it—QUICKLY TOO. THERE'S NO TIME TO LOSE. WRITE TODAY.

NATIONAL AERO INSTITUTE
Dept 121 C Morton Building, Chicago, Ill.

LEARN AVIATION MECHANICS
Train Yourself for the Aviation Service and the Aircraft Industry by taking advantage of
Our Ground Course in Aviation Mechanics
Affording preparation prior to entering Government Ground School, covering aero-dynamics, aero-engines, rigging and Lewis gunnery. Previous experience unnecessary.
Aviation Mechanics Course (6 weeks).....$60
Aero-Engine Course (3 weeks)..... 35
Wireless Course (4 weeks)..... 25
Write for Illustrated Booklet "W." "A Message to You on Aviation."

EAGLE AVIATION SCHOOL
110-114 West 42nd Street, New York

Books for Men
Wireless, Signal Corps, Aviation, Navigation. Best books on these subjects. Let us know your book needs. We are in close touch with all publishers. Our own publications are authoritative in their field. Orders promptly shipped.
WIRELESS PRESS, INC.
25 Elm Street New York City

PATENTS
THAT PROTECT AND PAY
Books and Advice Free
If you want to sell your patent, take it out through my office. HIGHEST REFERENCES. BEST RESULTS.
WATSON E. COLEMAN, Patent Lawyer
624 F. Street, N. W. Washington, D. C.

Earn Spare Time Money
Represent us in your community. Complete line of wireless literature for amateurs and professional operators, Signal Corps men, Naval Radio operators and men who expect to enter the Service. Liberal commissions. Active agents wanted.
WIRELESS PRESS, INC.
25 Elm Street New York City

Farm Wireless News

THE last vestige of isolation from the world has been banished from the farm. The farmer is no longer dependent upon the telephone, telegraph or newspaper to keep in touch with the outside world. For, if he installs a radio set like that shown in photographs (figures 1 and 2) he will be enabled to receive daily weather forecasts, market quotations and world news.

It may be mentioned that eight years ago, when Archie Banks of Delmar, Iowa, was a sixteen-year-old boy living on the farm of his father, a well-known livestock farmer, he had always been interested in machinery and mechanical devices. In the natural course of events, he installed a wireless outfit. Farmers who live near Mr. Banks now do not have to wait for the belated newspaper which the R. F. D. carrier brings. They are not caught unprepared by any sudden and unpredicted change of temperature, for the weather forecast is known by them as promptly as it is obtained by the man in the city.

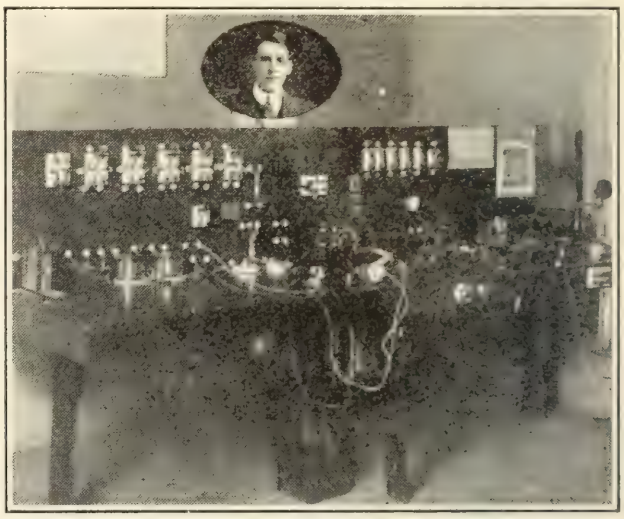


Figure 1—Showing Archie Banks and his wireless room

An interesting side-light surrounding Banks' experiments is the following: The traveler wandering along the road which leads to the Bank's home comes suddenly upon a large sign stretched across the road, upon which is painted in large words this placard: "Eat Honey. For Sale Here. To-day's Weather Report by Wireless

on the Next Curve. Archie Banks." A few rods further on, at the first turn in the road stands the large bulletin board eight feet high by five feet broad. Upon it Banks posts the weather forecasts and the daily news bulletin immediately it is received. Whoever drives by the Banks' home gets the news of the world as promptly and as accurately as the city man gets it from reading the bulletin board of the metropolitan newspaper office. Incidentally, now and then a traveler buys honey. Mr. Banks (now twenty-

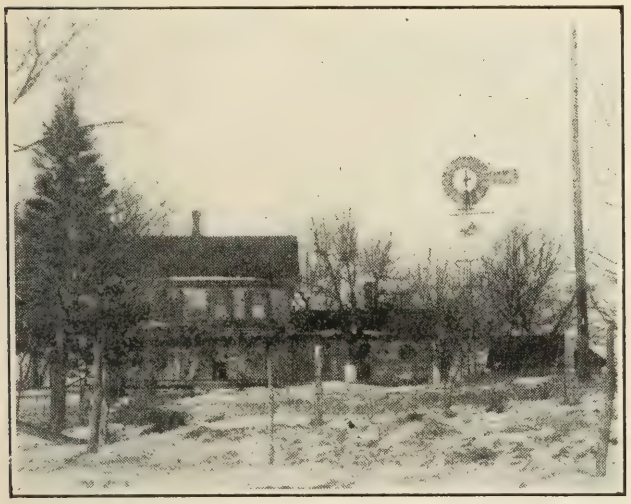


Figure 2—The wireless station on the farm

four years of age) owns and operates a farm of 160 acres, carrying on a general farming business. He has two particular hobbies, however,—electricity and bees. Prior to December 10th, he sold about 3,000 pounds of honey. He could sell much more if he had it, for his honey has a good uniform quality, and Delmar is in the midst of a rich honey section, many car-loads being shipped from there to all points east and west. Banks states that there was no thought of the business possibilities of his wireless service when it was first inaugurated but there is a close connection between the two.

He has received messages from Dariaon, Panama; Hanover, Germany; Mare Island and San Diego, California; Guantanamo Bay, Cuba; Arlington, Virginia; New York City, and all over the world. Signals from stations in the neighborhood of New York are so loud that they can be heard all over the house.

BEST TEXT BOOKS FOR MILITARY TRAINING

Newest editions—with all changes to date. Prompt shipments.

Military Signal Corps Manual. Maj. J. Andrew White	$1.50
Radio Telephony. Alfred N. Goldsmith	2.00
Practical Wireless Telegraphy. Elmer E. Bucher	1.50
Elementary Principles of Wireless. R. D. Bangay	1.00
How to Pass U. S. Government Wireless License Examinations	.50
How to Conduct a Radio Club	.50
Regimental and Company Forms	.85
Infantry Drill Regulations	.50
Field Service Regulations	.75
Army Transport Regulations	.50
Rules of Land Warfare	.75
Engineers' Field Manual	1.25
Manual for Non-Com. Officers and Privates	.50
Blue Jacket's Manual	1.00
Deck and Boat Book, U. S. Navy	.60
Sanitary Troops, Manual and Drill Regulations	.75
Manual for Army Bakers	.50
Ship and Gun Drill, U. S. N.	.60
Manual of Military Court Martial	1.10
Gunnery and Explosives for Artillery Officers	.40
Provisional Machine Gun Firing Manual, 1917	.50
Army Field Note Book, by Maj. H. R. Smalley	2.00
Now ready—New 1918 Edition—Military Aeroplanes, by Grover C. Loening; Revised, Simplified, Enlarged	4.75

Contains added chapters, more pictures, and is up to the minute in every detail. Used as text-book in American, Canadian and British Aviation Schools.

When ordering please add book postage to above prices.

WIRELESS PRESS, Inc.,
25 ELM STREET, NEW YORK CITY.

For the Man Who is Out to Earn a Commission.

"The demand in the Army for men possessing a knowledge of *radio* is so great that we have been unable to meet it. The Army radio service presents unlimited possibilities in the way of advancement and is expanding by leaps and bounds.

"A young man who acquires a working knowledge of *radio* before entering the Army prepares himself for early advancement."

This letter from a Lieut. Colonel of the Signal Corps, U. S. A., dated June 28, 1918, tells a vital story. The *wireless books* advertised in this magazine will help you make good. Orders promptly filled.

WIRELESS PRESS, Inc., 25 Elm St., New York City

LEARN TELEGRAPHY

Morse and Wireless—R. R. Accounting (Station Agency) also taught. **Tremendous Demand**—much greater than supply—**Permanent Positions Secured. Big Salaries**—recently raised. **Ideal Working Conditions**—short hours, vacations with pay sick and death benefits, etc.—prevailing. **Great Opportunities for Advancement. Women Operators** also greatly desired by Railways and Western Union. Tuition reasonable. Cheap living expenses—can be earned. Oldest and largest school—two large school buildings, investment exceeds $25,000.00—established 43 years. Endorsed by railway, Western Union and Marconi Telegraph officials. Large illustrated catalogue free. Correspondence courses also. Write today. **Enroll immediately.**

Dodge's Telegraph, Ry. & Wireless Institute
Green Street, Valparaiso, Ind.

Here Is a Handy Pocket Volume for the Radio Man

With the object of increasing the usefulness of this Handbook, the author has extended its scope without going any more deeply into the technical side of the subject.

Since the book has been used largely in the training of Telegraphists who are frequently called upon to take sole charge of complete Wireless Telegraph Installations, the author has endeavored to cover all parts of the transmitting and receiving apparatus in such a way as to give the student a sound working knowledge of the apparatus entrusted to his care.

ELEMENTARY PRINCIPLES OF WIRELESS TELEGRAPHY

BY R. D. BANGAY

CONTENTS

Continental Code—Symbols used in Diagrams—Electricity and Magnetism—Magnetism—The Principles of Wave Motion—Pressure Waves—Production of Waves—Production of High-Frequency Oscillations—Production of Oscillating Currents in an Aerial—Coupled Oscillatory Circuits—The Wavemeter—Wireless Telegraph Receivers—The Tuning Buzzer—The Electrolytic Detector—The Magnetic Detector—"Atmospherics"—Aerials—Distribution of Potential and Current Along Aerials—Masts—The Insulation of Aerials—INDEX.

PRICE, $1.00

Add 10c book postage to above price

WIRELESS PRESS, Inc.
25 Elm Street New York City

Man Wanted

in your community to earn money. Men about to enter the Signal Corps or Naval Radio divisions need our magazine and books. Big sellers wherever shown. Represent us and earn liberal commissions.

WIRELESS PRESS, INC.

25 Elm Street New York City

For weather reports and news bulletins he has a receiving set which copies spark stations like Iowa State College at Ames; Springfield, Illinois; and hundreds of other stations.

Signals can be copied from Key West, Florida, twenty feet away. Weather reports are received every day at noon from Ames. Scores of automobiles stop each day to look over the wireless station and to note the bulletins.

FRANK C. PERKINS.

A Telephone Without Diaphragms for Code Practice

TO experimenters and those who are studying the telegraph code in order to aid Uncle Sam, the following code practice device is offered. Buzzers are used more extensively than any other apparatus for this work, the usual method being to connect the telephones across the vibrator and one of the buzzer winding posts. Experimenters who have tried this method have obtained a deafening roar, and therefore the new method I present should appeal to them.

To carry out the idea, first remove the telephone diaphragms and use the receivers without them. A fair note of sufficient strength will be obtained for the usual work. The explanation of this phenomenon lies in the fact that a molecular change takes place in the magnet of the diaphragm due to the fluctuating current.

We have found this effect to be maximum on telephones of about 1500 ohms resistance. If the sound is not loud enough in the ordinary telephone, it is advisable, of course, to leave the telephone diaphragm in and to muffle the sound with a piece of felt or blotting paper.

Another method of reducing the sound is to insert a condenser in series with the telephone. Its capacity should be approximately .0001 microfarad.

E. DUSKIS, *New York*.

EDITORIAL NOTE: The simplest method of reducing the volume of sound emitted by the telephone diaphragm is to shunt it by a variable resistance of 100 or 200 ohms.—TECHNICAL EDITOR.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

A. B. L., New York City, inquires:

Ques.—(1) Can you give me a detailed diagram of the wiring on a four pole Eck motor such as furnished with the Eck Dynamo & Motor Company's motor generators supplied for wireless service?

Ans.—(1) A complete wiring diagram for this armature, which is known as the series

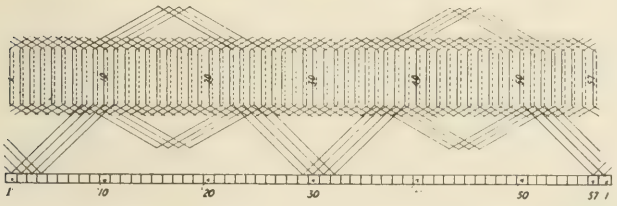


Figure 1—*Armature with retrogressive winding*

retrogressive winding, is shown in the accompanying figure 1. Please note that the dynamo has four poles and the commutator has fifty-seven bars and fifty-seven slots. The brushes are on the center lines of the poles.

* * *

G. F. B., Jersey City, N. J.:

We can give no advice on your 110 volt A. C. motor because we are not familiar with its construction. A more comprehensive description would be required to give a detailed answer.

* * *

R. W., Portsmouth, Ohio:

Multi-layered receiving transformer coils are tapped in the same way as single layered coils. It is only necessary to bring out a lead from the coil at the desired value of inductance.

The Bureau of Standards Bulletin No. 74 will answer your queries relative to the calculation of inductance and the distributed capacity of a tuning coil.

The effect of the ground lead on a wireless telegraph antenna is in general to double the wave length, the earth acting as an image of the aerial wires.

Replying to your last query, it is possible to exhaust vacuum tubes to .001 micron.

* * *

N. G., Midland, Michigan, inquires:

Ques.—(1) Can a so-called High-Low Auto Lamp be used as a vacuum tube by the addition of an external grid? This lamp, as you know, has two filaments. I

THE STANDARD WIRELESS TEXT BOOK OF TODAY

PRACTICAL WIRELESS TELEGRAPHY

BY ELMER E. BUCHER
Director of Instruction Marconi Institute

Revised Edition, enlarged, with new chapter on Location of Trouble—Maintenance—Repairs

More than 30,000 copies of this book have been sold up to date. It is now used by practically every school, college and training camp in this country. Army and Navy men find this book invaluable.

PRACTICAL WIRELESS TELEGRAPHY is the last word in wireless text books. It furnishes much information of utmost value in regard to the very latest styles of wireless sets now in use, and which has not appeared in print before.

This is the first wireless text book to treat each topic separately and completely, furnishing a progressive study from first principles to expert practice. Starting with elementary data, it progresses, chapter by chapter, over the entire field of wireless—fundamentals, construction and practical operation.

CONTENTS

Part I. Magnetism. The Magnetic Circuit.
Part II. The Production of Electromotive Force. Electric Current and Circuits.
Part III. Electromagnetic Induction. The Dynamo—The Flow of Alternating Current.
Part IV. Motor Generators. Hand and Automatic Motor Starters.
Part V. Storage Batteries and Charging Circuits.
Part VI. The Radio Transmitter. Condensers—Oscillation Generators—Radiation of Electrical Waves—Damping of Oscillations.
Part VII. Appliances for a Radio Transmitter. Spark Dischargers—Oscillation Transformers — Condensers — Transformers.
Part VIII. Aerials or Antennae.
Part IX. Receiving Circuits, Detectors and Tuning Apparatus. Standard Marconi Receiving Sets.
Part X. Auxiliary Apparatus or Emergency Transmitters.
Part XI. Practical Radio Measurements. Measurement of Wave Length—Decrement — Calibration — Transmitting and Receiving Apparatus.
Part XII. Standard Marine Sets of the American Marconi Company. Panel Transmitters — Composite Transmitters.
Part XIII. Marconi Direction Finder or Wireless Compass and its Application.
Part XIV. Transmitters of Undamped Oscillations. Arc Generators — Radio Frequency Alternators—Pliotron Oscillator.
Part XV. Receivers for Undamped Oscillations or Continuous Waves.
Part XVI. Marconi Transoceanic Radio Telegraphy.
Part XVII. Location of Trouble. Maintenance—Repairs.
APPENDIX

The 340 illustrations alone, specially drawn, form a complete diagrammatic study and impress upon the reader's mind a pictorial outline of the entire subject. Many of these illustrations reveal details of construction of the newest types of sets and apparatus never before published.

PRACTICAL WIRELESS TELEGRAPHY is a practical man's book from cover to cover and *up to the minute*. Size 330 pp. 6x9 inches, handsomely bound in full cloth with cover stamping in gold and black.

Cloth. Price $1.50 net.
Postage 15 cents

WIRELESS PRESS, Inc.,
25 ELM STREET, NEW YORK, N.Y.

RADIO MEN HAVE A REAL NEED FOR THIS BOOK

RADIO TELEPHONY

By Alfred N. Goldsmith, Ph. D.

Fellow of the Institute of Radio Engineers
Member of the American Institute of Electrical Engineers
Director of the Radio Telegraphic and Telephonic Laboratory of the College of the City of New York

This complete text on radio telephony is intended for radio engineers, radio electricians in the Navy, men in the Signal Corps and especially men in the Aviation Service who handle radio equipment. Amateurs and others who desire to be clearly informed concerning this newest and most interesting branch of electric communication will want this book.

It is written in clear style, and presupposes very little knowledge of radio. The text deals largely with the practical aspects of radio telephony and its future. It is copiously illustrated with wiring diagrams and previously unpublished photographs of "wireless telephone" apparatus.

IT IS THE ONLY BOOK TREATING THE SUBJECT OF RADIO TELEPHONY IN ALL ITS ASPECTS

Among the unusual features of the book are a description of how radio telephony was carried on over a distance of more than 5,000 miles; an illustrated description of an airplane radio telephone set; an illustrated description of a large ship radiophone set; numerous illustrated sections on smaller ship "wireless telephone" transmitters; land station radio telephone sets of all sizes.

Another noteworthy feature is a description of the method of transmitting a radio telephone message to a ship at sea, or across continent or ocean, including the number of persons involved. This material is in dialogue form and so worded as to require no previous knowledge of the subject.

Among the topics treated are: the construction and operation of the Armstrong oscillating audion circuits; the construction and use of bulb amplifiers; the construction of the great alternators of the Alexanderson and Goldschmidt systems and how they are controlled, especially for radio telephony.

The book is very complete, practically every aspect of radio telephony being covered in detail. There are over 400 separate topics listed in a carefully prepared index.

8vo. 256 pages. 226 illustrations.
Full cloth, stamped in gold. Price $2.00 net

Add 15c book postage

WIRELESS PRESS, INC.,

25 ELM STREET, NEW YORK, N.Y.

would use one of these as the plate. Is this practical?

Ans.—(1) We cannot answer this question precisely. Good results are obtained from a vacuum tube with an external grid, but whether this particular bulb will give the required electronic emission and the correct operating characteristics to act as an oscillation detector we are unable to state.

Ques.—(2) Can a Fleming valve be constructed to act as an oscillation detector by the addition of an external plate?

Ans.—(2) Yes.

* * *

E. E. M., New Orleans, La.:

It is not possible to answer your query in regard to the amount that the wave length of the antenna will be boosted by the insertion of a localized inductance, unless the inductance or capacity of the aerial is known.

* * *

R. D., Armstrong, B. C., Canada:

Current is not radiated from a wireless telegraph aerial, but the oscillation of the current in the antenna circuit is accompanied by static and magnetic fields which are detached from the aerial and radiated outward at a speed of 186,000 miles per second. The circuit of the antenna is completed through its electrostatic capacity to earth.

* * *

F. B. A., Reading, Pa., inquires:

Ques.—(1) Why is it necessary to use a condenser of a certain capacity for a wave length of 200 meters and to adjust it to the power output of the transformer?

Ans.—(1) This question is answered by the two following simple formulae:

$$W = C\ V^2 N$$

where W = the power in watts to be assumed by the transformer condenser circuit;
C = the capacity of the condenser in microfarads;
V = the applied potential in kilo volts and
N = the frequency of the condenser charging current.

It is readily seen that for a transformer of a given output a condenser of different capacity must be employed for the maximum efficiency.

The dimensions of a condenser for a 200 meter set are determined definitely by the oscillation frequency. Using the simple formula

$$\lambda = 59.6 \times \sqrt{L\ C}$$

we may assign some definite value to L. The minimum value will be about 1200 centimeters. Then from the foregoing formula we can determine the magnitude of C to obtain the required frequency of oscillation or wave length. In other words, if a condenser of excessive capacity were employed, the natural frequency of a circuit, with a fraction of a turn of the primary inductance of the oscillation transformer in the circuit, might be too low for

the required wave length. In other words, the wave length would exceed 200 meters.

Ques.—(2) Is a capacity of .008 microfarad correct for a ½ kw. 13,200 volt transformer?

Ans.—(2) If the set is to be operated at the wave length of 200 meters this is about the maximum capacity that may be employed.

Ques.—(3) How is the speed of a motor in revolutions per minute determined?

Ans.—(3) Preferably by means of a small speed indicator which can be purchased from any machinist's supply house at the price of $1.50.

Ques.—(4) With the above transformer and a condenser of correct capacity what should be the spark frequency of the rotary gap?

Ans.—(4) On the assumption that a non-synchronous rotary gap is to be employed it should be designed to give no more than 300 or 350 sparks per second.

Ques.—(5) How can the above set be adjusted so as to radiate a pure wave?

Ans.—(5) The purity of the wave is ultimately found by means of a wavemeter or decremeter, but in the event that you possess neither you could make this determination in a general way by simply "tuning" in the transmitter on your receiving apparatus. If the signals from your transmitter are heard at only one position of capacity of the shunt variable condenser, it indicates that the set is radiating a single wave, but if the signals can be heard distinctly at two points, a double wave emission is obtained and should be corrected. The correct way to insure a pure wave is to reduce the coupling between the primary and secondary windings of the oscillation transformer until a wavemeter on your receiving set indicates a single wave emission. You must keep in mind that such experiments as you describe will not be permitted during the time of the War.

* * *

H. W. M., Sydney, Nova Scotia, Can.:

The information you have given us is not sufficient to make an accurate calculation of the wave length range of your receiving apparatus, but if it is employed with a carborundum crystal rectifier, the probabilities are that you can put additional capacity across the secondary coil. Better response is obtained with crystal rectifier and vacuum valve detectors by keeping the shunt secondary condenser at low capacity and using large values of inductance for a given frequency of oscillation. We may say in general that the shunt capacity should not exceed .001 or .002 microfarad. A very common value is .0005 microfarad.

Transil oil, we believe, will work as satisfactorily in the variable condenser as castor oil.

We can give you no information regarding the strange calls you hear. These are probably Government signals.

It's Much Easier to Learn the Code by the Marconi-Victor Method

You Just Listen and Learn

These records for the teaching of the wireless code are proving remarkably popular and effective. Men are using them for individual instruction at home, in schools, camps and training stations.

Many of the leading institutes where wireless is being taught are using the **MARCONI-VICTOR RECORDS** for the rapid and efficient training of men.

The instructors in these schools are using these records in the beginners classes in order to make them familiar with the perfect reproduction of code sounds. As the student advances and reaches the intermediate class he finds these records wonderfully valuable in gaining speed. The advanced student is helped by training him how to concentrate and by making him thoroughly familiar with code words and figures.

Not only are these records proving popular in America but are being ordered in Japan and other foreign countries.

The new **MARCONI-VICTOR WIRELESS CODE INSTRUCTION RECORDS** were prepared by the Marconi Institute in collaboration with the Victor Talking Machine Company and are officially approved by the Marconi Wireless Telegraph Company of America.

The set consists of six double faced records each prepared by a code expert of years of practical experience.

These records provide a series of progressive lessons in elementary and advanced instruction for men in all divisions of Government and commercial service.

Order Your Set Today

BRIEF SUMMARY OF RECORDS

Lesson No.	Title
1	International Morse Code and Conventional signals.
2	International Morse Code, etc., continued.
3	Easy sentences and periods.
4	Easy sentences and periods.
5	Marconi Press, South Wellfleet station.
6	Messages with static interference.
7	Press with static.
8	Messages with erasures, etc.
9	Press with interference from second station.
10	Groups of figures.
11	Ten-letter dictionary words.
12	Ten-letter code words.

A set of six double-faced *Marconi-Victor Records*, complete in a container with instruction manual, specially priced at $6.00.

WIRELESS PRESS, Inc.
25 Elm Street New York City

Pan-American Wireless Telegraph and Telephone Company

EDWARD J. NALLY, President

233 Broadway **New York City**

WIRELESS STATION TO BE WORLD'S BIGGEST

Marconi Project in Argentina Includes Three Towers of Eiffel Size.

BUENOS AIRES, July 8.—The Marconi Company is to erect the largest wireless station in the world near Buenos Aires. Edward J. Nally, Vice President and General Manager of the company, has just closed a contract for the installation. The power of the new station, it is announced, will be 11,000 kilowatts, and three towers will be erected, each the size of the Eiffel Tower.

Germany, before the departure from Buenos Aires of Count Luxburg, the deposed German Minister, made every effort to gain the consent of the Argentine Government to the maintenance of a wireless station powerful enough to insure direct communication with the big German station at Nauen. Such a station has been established, but when Luxburg received his passports this station was dismantled. It had been operating under a temporary concession to enable a German syndicate to conduct experiments, on the promise that the station would merely attempt to receive Nauen dispatches and would not be used for the transmission of messages. It later became known that the station was sending, as well as receiving. This German station was situated about forty-five miles from Buenos Aires. The Argentine Government sealed, and later dismantled, it.

From New York Times, July 9, 1918

THE main purpose of the PAN - AMERICAN WIRELESS TELEGRAPH AND TELEPHONE CO. is the closer linking of the Americas by means of the modern and economical method of communication—Radio Telegraphy and Telephony.

¶ A connection with the Marconi Wireless Telegraph Company of America extends its wireless telegraph facilities to Europe and the Orient.

¶ High speed duplex working and reduced rates will be features of the new competitive service of the Pan-American Wireless Telegraph and Telephone Company.

Pan-American Wireless Telegraph and Telephone Company

233 Broadway **New York City**

Thousands of

Edison Army-Navy Special Storage Batteries

are in extensive use by the *Radio Divisions* of the United States and all Allied Governments, because the

Edison

is the most rugged, most practical

Storage Battery

in the world.

Our New Type W2-T, Army-Navy Special Edison Battery, of $2\frac{1}{2}$ ampere hour capacity, very small and of light weight, is adopted by at least one great Nation as its standard for operating the wing circuit of electron relays.

The types B-2 and B-4 batteries have long been universally conceded as being the best obtainable batteries for operating the filament circuit of electron relays and for reserve source of power for the entire radio apparatus.

ADDRESS

MILLER-REESE-HUTCHISON, INC.

Storage Battery Specialists Orange, N. J.

CROCKER-WHEELER

LIKE THE PYRAMIDS, BUILT TO LAST

ELECTRIC MOTORS

A Definite Standard of Quality

backed by over 30 years practical experience in Electrical Design and Manufacture, guarantees the reliability and accuracy of

C-W Radio Generators

FOR

Wireless Telegraphy

AND

Wireless Telephony

The Crocker-Wheeler Company manufactures Radio Generators for land stations, ships, portable stations and for a wide miscellany of special purposes.

CROCKER-WHEELER

COMPANY

AMPERE, N.J.

BALTIMORE
BIRMINGHAM
BOSTON
CHICAGO
CLEVELAND
DENVER
DETROIT
NEW HAVEN
NEWARK
NEW YORK
PHILADELPHIA
PITTSBURGH
ST. PAUL
SAN FRANCISCO
SYRACUSE